

# THE EDUCATIONAL DEVELOPMENT OF CHILDREN

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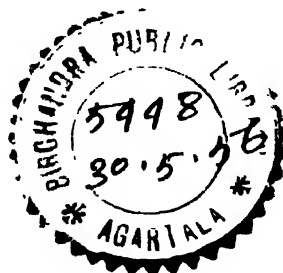
THE TEACHER'S GUIDE TO THE  
KEEPING OF SCHOOL RECORDS

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With a Foreword by  
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UNIVERSITY OF LONDON PRESS, LTD.  
WARWICK SQUARE, LONDON, E.C.4

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## FOREWORD

TEACHERS have themselves been among the first to claim that education, to be truly efficient, should be adapted to the needs of each individual child. Their maxim has been : fit the school to the pupil, not the pupil to the school. But such a principle implies that the function of the teacher is by no means limited to actual teaching. To ensure that his teaching is successful, he must first make a psychological study of every boy or girl in his class. To teach Arithmetic to Richard or Geography to George, it is not sufficient to know the principles of Arithmetic or the facts of Geography : he must also know Richard and George. Under the provisions of the new Education Act it should now be practicable to carry this aim more effectively into practice.

But such studies are useless unless their results are systematically recorded. Indeed, without a record the study itself is scarcely practicable. It follows that, just as every doctor in a hospital keeps a case-history and a temperature chart for every one of his patients, so in the school every teacher should draw up a cumulative report, setting out the special characteristics and general progress of each pupil. And the simplest and most convenient way of doing this will be to use what is now commonly known as a " school record card ".

Many teachers have spontaneously introduced some such system. But in the past, each commonly improvised his own favourite device in the light of personal experience and common sense. Some have used book-lets, others roneo'd forms, others again sheets with printed headings, analogous to those of the medical cards. If, however, such studies are to be genuinely scientific, the teacher must consider first of all what particular qualities and points he is to observe, and how their influence is to be assessed or measured. And here, just as the doctor borrows his descriptive terms from the



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anatomist or physiologist, so the teacher requires the help of those educational psychologists who have specialized in this particular field.

In 1914, when I was first appointed educational psychologist under the London County Council, I quickly found that I had myself to keep a "personal file" for each of my cases; and in my published *Reports* I outlined a tentative scheme, which has since been variously amplified and modified to suit different requirements. However, the record-schemes that are needed by the professional psychologist are likely to be too elaborate and technical for the everyday uses of the teacher. Hence a simplified version, still based on sound psychological principles, is an urgent need.

Mr. Glassey and Dr. Weeks have long devoted much thought to this problem; and the results of their efforts are described in the present volume. As they point out, all such suggestions must still be regarded as in an experimental stage. But their value and their improvement can only be determined by actual trial on a large scale. Quite rightly, the authors insist that a school record should be much more than a mere record of school progress. Every aspect of the child's personality must be included; and it is equally essential to know the details of his social background and the views and attitudes of his parents.

In order that the teacher shall use their scheme intelligently, Dr. Weeks and Mr. Glassey have described, in lucid and non-technical fashion, the scientific basis of their proposals, and the way in which their record card is to be used. Their book, therefore, may be heartily commended to the practical teacher; and I am convinced that teachers themselves will eagerly welcome this contribution to their everyday work.

CYRIL BURT.

## PREFACE

**MOST teachers keep records of the progress of their pupils. Some relate with pride anecdotes about the performances of their most successful boys and girls; others compile case-histories of children with peculiar problems—the genius, the backward child, the delinquent and the mal-adjusted pupils; nearly all write reports and use marks to indicate the standards of achievement of the children in their charge. But, generally speaking, the methods used are too haphazard and the opinions formed are based too much upon personal impressions for them to be of much use in solving educational problems. Moreover, there is often no attempt to make these records cumulative; that is, they tend to refer to the child's behaviour and performance during one session of his school life, without attempting to link them to the observations made in previous sessions. In order to make them efficient instruments for the guidance of children we should attempt to make the records objective in outlook, to base them upon systematic observations covering the whole of the child's school life, and to use measurements which conform with some generally accepted standards. Such a scientific aim cannot be completely achieved, for we shall be dealing with factors which depend upon human personality. But we shall be near the mark if we combine the knowledge gained from his experience by the teacher with the results of psychological, medical, sociological and statistical research. Such a method of recording pupils' development is suggested in this book.**

The Education Act of 1944 has stated the principle that every child should be educated according to his "age, ability and aptitude". Children can be classified

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by these criteria only if we have means of measuring abilities and aptitudes in such a way that one child's measurement is comparable with those of other children. It has long been realized that the traditional type of examination, even when applied in its modern form, is not entirely satisfactory for this purpose, and in consequence it has been suggested that whenever selection has to be made, it would be well to consider the people who have known the children for some time—their parents and their teachers. The Norwood Report states this view clearly :

“ We would regard the judgment of the teachers—based upon observation of . . . certain qualities . . . as the most important factor to be taken into consideration in the recommendation of the appropriate education for (the pupils).” <sup>1</sup>

At the present time the great difficulty is that these observers usually give only a personal view. As the Norwood Committee pointed out : “ The task which will fall upon teachers is the task of discovering what are the necessary data for giving a judgment upon a child, and how such data are best obtained, recorded and used for the making of a full and trustworthy judgment.” <sup>2</sup> It is suggested by many educationists, therefore, that the records which some schools are already keeping for their own purposes—such as the recording of achievement, the making of promotions, and the writing of testimonials—should be modified in the light of recent discoveries and should be kept by all schools, so that it should be possible to follow the child's school career over a number of years, and to form a fair estimate of his abilities, interests, and temperament.

Record cards are still in the experimental stage, and will need to be altered from time to time as the results of

<sup>1</sup> Norwood Report, p. 17.

<sup>2</sup> *Ibid.*, p. 47.

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practical experience in their use become available. The Norwood Committee recommended that "The keeping of school records from the primary stage to the end of the school course should be made the subject of immediate investigation and research".<sup>1</sup> This opinion received official support when the Ministry of Education issued Circular 151 on "School Records of Individual Development" on 28 July, 1947, and was further reinforced by the conclusion reached by the Secondary School Examinations Council in September, 1947: "We consider that the practice of maintaining careful records of individual pupils should be developed as rapidly and thoroughly as possible until it becomes general. We regard such cumulative records as helpful to any attempt to fit the course of study to the aptitudes and abilities of the pupils."

Some of these investigations will be conducted by the specialists. Psychologists will help by their investigations into the factors of human ability and disposition, and the psychometrists by building scales to measure these factors in the children. The Medical Officers of Health, the statisticians, and the sociologists will play their parts. But perhaps the most important task will fall to the teachers. They will be responsible for the collection of the data and for testing in practice the conclusions which are drawn from them.

But there are many difficulties. Many teachers have only a vague knowledge of how to fill in, interpret, and use the record cards. A large number of them have turned to learned treatises dealing with some aspect of the subject. Unfortunately most of these works only baffle the average teacher, who has no understanding of the technical vocabulary of the psychological researchers, little knowledge of the science of statistics, and is not

<sup>1</sup> Norwood Report, p. 141.

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familiar with the history of recent developments in these fields. Again, the information is scattered over many books and is often hard to find. This book is written in an effort to answer the questions of the ordinary class teacher and to enable him to master the necessary techniques. It is not intended for the expert. Consequently it omits a great deal of theory which we do not feel to be relevant to the teacher's need. Many teachers will prove themselves clever analysts of human character without an understanding of factorial analysis, just as many a gardener grows a fine supply of vegetables without understanding the precise function of plant hormones.

We wish to acknowledge our indebtedness to the many friends—psychologists, doctors, teachers, boys and girls—who have co-operated with us in the work upon which this book is based. In particular we should like to express our appreciation of the facilities given to us by Mr. Herbert Roberts, Chief Education Officer of Croydon, and by Mr. Norris Greenwood, his deputy, and of the kindly help and advice given by Sir Cyril Burt and Miss Gertrude Keir. We are grateful to Professor C. W. Valentine for permission to reproduce from an article published in *The British Journal of Educational Psychology* some of the passages in the chapter on Interests. We thank, too, Dr. J. M. Tait, O.B.E., M.D., Dr. K. F. Weeks, M.B., B.S., and Miss E. A. White for their generous aid in the chapter on Physical Qualities, Mr. T. A. Glassey for his constructive suggestions and for his help in reading the proofs, and Mrs. E. J. Weeks for her many services so graciously rendered.

Finally, as the authors are in the service of the Croydon Education Committee, it is necessary to state that that body accepts no responsibility for any opinions or conclusions in this work.

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## CHAPTER I

### INTRODUCTION

#### THE TEACHERS' PROBLEMS

UNTIL the beginning of the present century nearly all progress in education depended upon the insight and personal opinions of individual reformers and, although in the last fifty years there has been an increasing devotion to scientific research into methods, curricula, and guidance, in England it was not until very recently that an attempt was made to organize that research. In consequence today very little is known about some of the fundamental problems of the teacher. At what age should we begin to teach the child reading, writing, number, and the manual skills? How should the methods used be varied to meet individual needs, particularly those of the backward and the brilliant children? How far can any particular child go in a subject at any particular stage of his development? How should children be selected for the education suitable to their abilities and aptitudes, and at what age should they be allowed to undertake special studies? What evidence is there of the existence of special abilities and aptitudes in any child, and how can they be measured? Can schemes of work be arranged in such a way that they incorporate the discoveries of doctors, psychologists, and educationists concerning the physical and mental growth of the child? How can we ensure the full development of the character and personality of each child, especially if we have a large class of children of both sexes? What should we do with John Smith, whose work, although he has high general mental capacity, is of a very low standard? How shall

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we treat children who are maladjusted in various ways, whose behaviour is anti-social, and who are defiant, suspicious, resentful, and unhappy? There are many more similar problems to which only tentative answers can as yet be given.

The time has come when we wish to sift all the available evidence on these matters so that our practice may depend upon conclusions drawn not from isolated experiences but from the wealth of experience of all teachers. The first task is to collect the evidence, and this can be done only by asking teachers to record their observations of the children they teach and to make judgments upon these observations. We want to know all we can find out about each child—his history, his background, his physical, mental, emotional, and moral states, the measures taken to develop his abilities, aptitudes, and character, and the results of these measures. It is unlikely that all these problems will be solved precisely and accurately, for teaching, in the last resort, will always remain an art, and the solutions will often be based upon the judgment, insight, and vision of the teacher. But these solutions will be all the more reliable when they are built upon the broad foundation of the observations scientifically made of many colleagues.

### THE USES OF RECORD CARDS

Many teachers are sceptical about the usefulness of school records. Exhausted by teaching a large class, by long hours of marking, by collecting money, issuing milk, and supervising school meals, many teachers wonder whether the hours spent completing record cards is time well spent. They recall how at college they spent long hours comparing the ideas of Plato, Aquinas, Locke, Rousseau, Pestalozzi, and others without finding "rules of thumb" which would be of use to them in solving the

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problems of the classroom. To have read Plato's "Republic" appeared not to be a useful qualification when Jimmy Brown seemed incapable of finding prime factors and when Mary Brown did not even care whether she wrote "receive" or "recieve". Record cards seem to these sceptics to be useless; they imagine them to be too much a matter of theory and too little concerned with practice. This is a mistaken notion, for records of pupils' development are essentially practical; they will be valuable to teachers in their daily tasks, and may well become good educational instruments in the widest sense. It will be possible, for instance, by studying a large number of school records, to draw conclusions about the usual development of normal children, and in this way the teacher will come to know the general needs of children at any particular stage in their school progress. When the characteristics of the behaviour of the average child in typical situations and activities are known, it is relatively easy to note the differences in any child and the attendant circumstances which may be the cause of the differences. With this knowledge available, it should be possible to cater for the special needs of each child.

Indeed, the main use of school records is to guide the teacher in adapting the work of the school to the needs of the individual child. Since they attempt to describe the development of the children physically, mentally, emotionally, and morally, from the time they enter school until the time they leave, the records will give a sound basis upon which to decide the educational method to be used at each phase. The evidence presented will reveal the strong points and the weaknesses of each child, will make evident any inconsistency between innate ability and attainment, and will show us where special attention is needed. The school record will reveal the child's interests and the main trends in his development over a number

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of years, and on this basis we can plot more accurately the lines of his probable progress at school and forecast more reliably the part he will play in life than we can if we rely upon unrecorded impressions. As we gain more experience in the use of record cards and when we have devised means of making our assessments on them more precise, these forecasts will become even more reliable. In brief, pupils' records, if well used, can help to raise the standard of attainment, to promote good health, to develop well-harmonized personalities, to enrich the character, and to make the child happy and contented.

But we are concerned not merely with the education of the individual as an individual, but with the evolution of a community which is healthy and happy. We are therefore concerned with the child as a member of society. If we are to train him successfully as a social being, we must know something of his environment—the people among whom he lives as well as the district where he resides. The record will be a means of co-operating with the parents to this end. We should record the available facts about the child's parents, his home and its standard of physical welfare and nourishment, his emotional relationships with the rest of the family, the encouragement he gets out of school, the children he plays with, and how he spends his leisure time.<sup>1</sup> This information is often of great value in the planning of the school work, and is especially valuable in cases of maladjustment.

The problem of maladjustment in children is today a grave one. The complexities of modern life make it difficult for adults to adjust themselves to their environ-

<sup>1</sup> The collection of this information may be very dangerous. The teacher should always take care that nothing is done which is likely to antagonize the parents or to rouse the disapproval of the local education authorities. The importance of retaining the good-will of the parents cannot be over-emphasized.

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ment, and so we find them engaged in uncongenial occupations, living in houses which are inadequate to their needs, and lacking any satisfactory form of recreation. The tension of the economic and political situations produces even greater strain. In these circumstances the child's home often lacks that calmness and brightness which he requires. Emotional disturbances at home produce a sense of insecurity in the child mind. This in turn produces behaviour in the child which is not normal. In the more violent cases we have anti-social activity and delinquency. But there are many more subtle reactions which may pass unnoticed unless the teacher is alert. A boy may be unable to learn to read or to add because he has associated, in a fanciful but to him a real way, these processes with a father whom he fears. Emotional upsets interfere powerfully with a child's ability to attend to his lessons and with his performance in school. These disturbances may often be most easily detected in the infant school. As the child grows older the problem may remain, and may produce neurotic disturbances and affect his conduct, but it may be difficult to trace the cause of the child's aberration unless his early life has been recorded as fully as possible.

It is obvious that the recording of the school life of the child by a teacher is a valuable way of transmitting knowledge about the child to another teacher or from one school to another. In this way the second teacher can approach the child in the right manner at once without having to wait to discover the knowledge afresh. But he must not accept unthinkingly all the assessments of his predecessor. Children react differently to different teachers, and, in consequence, one teacher may perceive what was not revealed to the other.

A record of his school work and personality is particularly valuable when a decision has to be made as to the

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type of education best suited to the child, and in this connection it is likely to be even more useful as teachers become more expert in their recordings. One such occasion is the time when children are transferred from the primary schools to the secondary schools. At the present time we still have to use an examination as a means of distinguishing the abilities of the children, but in the future it may be possible to make the decisions by methods which contain fewer chance elements than the formal examination. The White Paper on "Educational Reconstruction" was looking forward to this time, when it proposed: "In the future, children at the age of about 11 should be classified, not on the results of a competitive test, but on the assessment of their individual aptitudes largely by such means as school records supplemented, if necessary, by intelligence tests, due regard being had to their parents' wishes, and the careers they have in mind."<sup>1</sup> In certain instances it may be necessary for specially trained men and women to interview the boys and girls concerned, for there may be no clear indication of the type of education which is most suitable to them. A glance at the school record of a child will enable the interviewer to establish contact with him and to set him at his ease. Above all, it will be possible to avoid those questions which produce a high emotional tone and either lead to an embarrassed silence or perhaps a flood of tears.

An examination which has recently been the subject of much discussion is the School Certificate Examination. Many would like to abolish it, and the suggestions of the Secondary School Examinations Council<sup>2</sup> that it should be abolished in its present form in 1950 and a new examination set to be taken only by pupils above the compulsory school age were accepted, with slight modifications, by

<sup>1</sup> "Educational Reconstruction," p. 9.

<sup>2</sup> "Examinations in Secondary Schools," H.M.S.O., 1947.

## INTRODUCTION

the Minister of Education in Circular 168, dated 23/4/48.<sup>1</sup> When the new proposals come into operation something will be needed to take the place of the examination, for at present it is the means of selecting youths for many posts. It is suggested that the place could be taken by school records, and that an abstract of his record could be given to the child when he left school, so that he could use it as a guide to the Juvenile Employment Officer and to employers as to his suitability for the post for which he was applying. The report of the Secondary Schools Examination Council states this clearly. "These records will not only help to determine the courses of study in school but they will also provide material for a full assessment of the pupil when he leaves school and passes on into employment or into further full-time education." Every pupil on leaving a secondary school should be provided with a comprehensive school report containing the fullest possible positive information about him, his abilities, and his potentialities. "By means of this report and by all other available means the school should play its part in conjunction with the Juvenile Employment Service, the parents, and prospective employer in guiding pupils towards careers which they will find suitable and satisfying." In actual practice this vocational guidance will begin earlier, for, on the basis of the information in the records, pupils will be advised some time before they leave school what type of post is likely to be congenial to them and what special courses at school they should take accordingly.

<sup>1</sup> The chief modifications are -

1. The existing School Certificate and Higher School Certificate Examinations will be discontinued in 1951
2. No boys and girls under 16 years of age on September 1st will be allowed to sit the new-style examination.



## KEEPING THE RECORD

The form of the school record will vary according to the age of the child; for that which is appropriate to the infant of 5 years of age will be inadequate for the members of a sixth form at a grammar school. It is advisable, therefore, to have separate cards for each group—Infants, Primary, and Secondary. Some Authorities prefer to keep these together in booklet form; others carry forward important extracts from each card to the next.

The information should be recorded with great care in handwriting which is legible. The authors have been much surprised by the elementary mistakes occasionally made by some teachers. It is a common slip to put the date when the entry is made instead of the date of birth. In some instances the address of the child has indicated erroneously that it lived in the area served by another authority from whom it seemed educational expenses should be claimed.

School records should be scientific documents, stating facts in an objective impersonal manner. It will at once be realized that this aim is never achieved, for in certain aspects of character and personality we have to rely for our measurements upon personal estimates. But this should not discourage us; for experience gained in the use of school records, and inquiries and researches made in the light of that experience, will enable us to make our assessments more accurate. Moreover, although the aim is to be scientific, it would be wrong to treat the children as dead specimens in a laboratory. Indeed, this is impossible, for the relationship between the teacher and the child is a personal one, and, since each child is a unique personality, our recordings even though they become much more scientific, will never be able to express completely this spiritual relationship. Nevertheless, when making

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our assessments we must not allow them to be coloured by any bias or partiality. The more objective we make them, the greater will be our resulting understanding of the boys and girls, the more beneficial our treatment, and the better our chance of educating them for a life of happiness and of service to mankind.

The estimates of ability, interest, and character are more reliable when based upon observations of the child's behaviour in as wide a variety of situations and activities as possible. Our knowledge must not be confined to his words and actions in the classroom, but to his behaviour in the corridors and playground, on the playing-fields, in the street, in camp, on school journeys, and as far as possible in his home. Though much of the life outside school is not easily observed by the teacher, much may be revealed quite naturally in the child's conversation and in his play. "In his play he will show us his fears and wishes and active interests, what his mind is occupied with when left to itself, what questions he wants to ask of life, what he is trying to do or to understand, what he would like to become, what view he has of us (*e.g.*, when he plays 'teacher') or of his parents. He may give us information in this way which we can then use in order to understand his response, or lack of response, to our efforts to teach him or to direct his activities."<sup>1</sup>

The final responsibility for seeing that the information is entered and checked will fall on the headteacher, but he should not rely upon his own judgment alone for the purpose of making estimates, although in a small school he may be tempted to do so because he feels that he knows the children at least as well as the class teacher. An estimate which is based upon the well-informed opinions of several teachers is likely to be more reliable than one which

<sup>1</sup> Dr. Susan Isaacs in the chapter on "Suggestions for Infant School Teachers" in "The Educational Guidance of the School Child," p. 65.

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depends on the judgment of a single observer. In order to have the benefit of several opinions, schools can be organized in several ways. In some schools all the members of the staff who teach a child send in assessments, and these are collated by the form master. In other schools the tutorial system is used, and by this means each member of the staff is made responsible for several pupils throughout their school careers. The great advantage of this method is that each session the teacher receives only five or six new members of his group, and he can give them much attention in their first year. The drawback is that at certain stages of their careers he may have very little contact with them. The essentials of a successful system are that each pupil should be assigned to a particular member of the staff, and that the assessments of his ability and aptitudes should be based upon the judgments of all the members of the staff who have opportunities of observing his characteristics. Staff meetings and group discussions for this purpose can be stimulating and useful, but they should not be held until each member of the staff concerned has made his independent assessments.

Lastly, school records should be confidential in the strictest sense. For this reason it is sometimes advisable to use a code instead of a name on the card. They should not be left lying on classroom desks. Parents should not be allowed to see them, but should be given reports based on them. When leaving school, the report given to the child as a testimonial should be based upon his school record, but it should not be a copy of it.

## THE INTERPRETATION OF SCHOOL RECORDS

The consideration of the significance of the information gathered and the decision as to the educational treatment to be given to the child are the most important, and perhaps

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the most difficult, tasks which the teacher has to perform in the use of school records. Facility and sureness will come only after considerable experience. But the teacher can considerably shorten the period of his apprenticeship by noting carefully the methods used for each child and the results of those methods in the space on the record cards for "Treatment Given" and "Results of Treatment Given".

It is beyond the scope of this book to suggest remedial action for all the particular problems that may occur. For that purpose readers are referred to textbooks on child psychology and child guidance.<sup>1</sup> But one or two general principles of interpretation may be noted.

When considering his record of development we must regard the child as a simple indivisible whole, not as an aggregate of the qualities listed on the card. In the first place, we must bear in mind that psychologists are not agreed on what are the elements of disposition,<sup>2</sup> and in consequence the qualities listed on the school records cannot be regarded as psychological entities, but as characteristic forms of human behaviour. Secondly we must remember that in actual practice it is impossible to isolate these qualities, for they are all closely inter-related, and in making our judgments we must be careful not to allow our assessments of one quality to influence our assessments of other qualities.<sup>3</sup> Again, the elements are fused together in innumerable ways, so that no two personalities are alike, and in the present state of knowledge we cannot say with certainty what will be the

<sup>1</sup> See Bibliography in Appendix III

<sup>2</sup> Professor Cattell, in his book "Description and Measurement of Personality," has tried to show by analysing the work of other psychologists that there are twelve fundamental traits. But it is quite possible that what he regards as elemental may be found to be complex and vice versa.

<sup>3</sup> This is aptly called the "halo" effect.

## EDUCATIONAL DEVELOPMENT OF CHILDREN

outcome to the child as a whole of treating one aspect of his development. A child with a saint-like character may be of low attainment in school studies. We may discover a process by means of which his attainment can be improved. But in so doing we shall affect the child's character, and we cannot forecast with any certainty what that effect will be. In all that we do, therefore, it is essential to look at the child as a whole. Only after years of patient observation shall we be in a position to predict with any accuracy the effects of our methods on the individual.

There is a danger when the personalities of children are analysed, as they are in school records, of mistaking the significance of any one assessment. For instance, it is usual to exaggerate the importance of the general mental ability of the child. Since a child with a high innate ability can learn quickly and can go far in a subject, and one with less innate ability learns slowly and cannot go so far in the subject, the one is often regarded with admiration and the other is looked upon as a good-for-nothing. Teachers who are in charge of B-stream children often fall into this error. They create a "B" atmosphere. Instead of setting the children a "B" standard and praising them when they have achieved it, it is usual to set them a standard that is far too high and to reprove them for failure. This sense of failure is extended from English and Arithmetic to other subjects, and from them to the whole of the child's life. The teacher would shudder at the thought of bringing a germ of diphtheria into the classroom, but he does not hesitate to plant similar infection in the child's mind. Many of these children of lower mental capacity have other qualities, which are invaluable to man, but which are overlooked because too much importance is given to this one factor.

When the record card reveals that a child has a par-

## INTRODUCTION

ticular difficulty, his teacher should first attempt to discover the cause of that difficulty. Rule-of-thumb methods are of little value, for what is true of one child may not be true of another. Children react differently to given stimuli. One boy may enjoy a joke at his own expense, but another will resent it. In some instances the cause of disturbance may be clearly seen, but often it must be sought in some other aspect of the child's life from that in which it occurs. Difficulties at home frequently cause emotional disturbances in infants which produce unacceptable behaviour, unhealthy characteristics, or inability to master their school work. Emotional conflicts caused by the child's inability to adjust himself to his fellows and to his environment may produce violent clandestine behaviour; a boy who is small of stature and of weak physique may attempt to satisfy his self-esteem by some destructive action or by secretly laying a trap for a bigger and stronger schoolfellow. When the cause has been diagnosed, then the teacher will attempt to devise means to meet the child's needs. Not often will the teacher be able to diagnose the cause with certainty, for often there are multiple causes, most of which will be hidden, so he must proceed cautiously and experimentally, noting carefully the behaviour of the child.

When in doubt, and in cases of persistent dishonesty, stammering, sex irregularity, and extreme solitariness, the teacher should consult an expert. The dangers of playing at psychology are as great as those arising from playing with electricity. At all times it is well to discuss problems of interpretation and to compare methods of treatment with other teachers.

Before giving special attention to a child, the teacher must always make sure that he needs it. Many of the shortcomings of children are normal at early stages of development, and should not be taken seriously. A child

## EDUCATIONAL DEVELOPMENT OF CHILDREN

of five or six often cannot distinguish between what has happened to him and what he has imagined; he is inclined to "romance". His tales must not be treated as falsehoods.

Above all, the teacher must not interfere unduly with the natural development of the child. There must be no attempt to mould all children to a pattern, for each child must develop his own individuality. The teacher, as far as he can, will strengthen his pupils where they are weak, and enable them to develop their strong points.

Finally, school records are not ends in themselves: they are maps to guide us in plotting the voyages which our children are to undertake. They enable us to lead them with greater understanding of their needs, and the more scientific they are the wiser is our guidance likely to be. "Though the most we can ever hope to achieve is but a glimpse of a child's personality, the record system helps to reveal potentialities that may otherwise be concealed, owing to the great difficulty that there is in understanding, without the aid of scientific method, the manifold nature of the different character tendencies that are to be found in the same individual."<sup>1</sup> But, as we have said earlier, these are early days in the use of school records, and the modifications made in the light of further experience are likely to make them more and more efficient. Experiments in their use by teachers are amongst the great needs of the moment. Such inquiries will of necessity lead to research into new methods of teaching and new types of organization. When their use becomes widespread there will be many fresh ideas and new developments in educational practice. The records of the mental and physical development of children are likely to be among the chief instruments in the great age of educational exploration and discovery which appears to be at hand.

<sup>1</sup> K. S. Innes in the introduction to "The Educational Guidance of the School Child".

## ELEMENTARY STATISTICS

MOST of us have had some experience of the application of statistics to everyday problems, although at the time we may not have been conscious of the fact that we were using statistical methods. We have calculated averages and drawn graphs. These are two of the devices used by statisticians; the first is a measurement which represents a group as a whole where each member differs from the others, and the second indicates pictorially general tendencies or variabilities within the group. For example, if we mark some examination answers, the marks of the candidates may well be all different, but the average mark will give some indication of the performance of the group as a whole. If we wished to see at a glance the variability in performance of the candidates, we could plot the marks of the individuals on a graph. All teachers are familiar with these devices. Most of the statistical knowledge required for completing and interpreting record cards is only an extension of these basic processes.

## VARIATION AND MEASUREMENT

For his convenience in dealing with the material world, man has established certain fixed measures, such as those for height, weight, and money. In his early days man was satisfied to say that one man was a head taller than his neighbour, that his horse was so many "hands" high, that his land was so many paces long and so many paces wide. As heads and hands and paces varied, it became apparent that these measures were unsatisfactory, and so a standard yard was fixed: it is the length at 62° F. between two gold studs on an iridio-platinum bar in the



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custody of the Board of Trade. With this as a standard unit, certain fixed relationships have been agreed; there are always twelve inches in one foot, and three feet in a yard, and 1760 yards make a mile. Similarly, we have built up other standard measures such as sixteen ounces to a pound, four quarts to a gallon, and twenty shillings in a pound. Other standard units—candle-power, calories, horse-power—enable us to measure luminosity, the heat produced by burning a substance, and the work done by a machine.

With one or other of these standards man can measure his physical environment. For example, he can measure the ratio in which oxygen combines with copper in cupric oxide. If he uses the units of weight as his measure he will find that eight units of oxygen always combine with 31.785 units of copper. This relationship is a constant. That is, if we analyse some thousands of samples of pure cupric oxide, the relationship of the weights of copper to oxygen will always be the same (eight to 31.785), so that, if we plotted the weight of copper on the *Y* axis against the corresponding weight of oxygen on the *X* axis, the graph would be a straight line.

But often we wish to make measurements of a population<sup>1</sup> samples of which may vary considerably. For instance, the height of men and women varies from the giant to the dwarf; beans of the same species are of different weights and colours; and hair or nails may be of varied thickness. Often for practical purposes we require to know the general tendency and the variability within the measurements of any such group; we must have a means of expressing simply a large number of measurements of such variable specimens. For this purpose, and to understand and interpret the results, the science of

<sup>1</sup> In statistics each person or object to be measured is called a "case": the total number of cases is called the "population".

## ELEMENTARY STATISTICS

statistics has been invented. In all the social sciences, including education, an elementary knowledge of this branch of mathematics is essential.

This need not deter teachers. The simple principles it uses can be easily understood, and its formulæ can be applied by anyone with a knowledge of the four arithmetical processes. Naturally teachers who are specially interested in this aspect of their work will pursue the matter further, and study the mathematical principles upon which the science is based. But this is not necessary for the class teacher. Indeed, the methods are often employed by the ordinary man or woman in daily life without any knowledge of the science, just as many people drive cars without a knowledge of the physics and chemistry of the internal-combustion engine. There is no doubt that it would be better if all teachers were able statisticians. But, then, it would be better if they were all trained in psychology, medicine, philosophy, logic, and a good many other subjects besides. We can all, however, grasp a sufficient knowledge of these subjects to serve our purpose. A few hours' study will make the teacher sufficiently acquainted with statistics to be able to enter the information on the record cards adequately and to interpret it efficiently.

In addition to the problem of the mathematics of variability, there is the difficulty of the accurate measurement of the characteristics, abilities, interests, and dispositions of human beings. For example, the attitudes of men and women towards the Church may vary from extreme favour to extreme disfavour. Between these two extreme positions it is possible to imagine that there are any number of different attitudes; and the difference between any one position and the next may be so small that if a large number of such positions were plotted on a graph they would appear as a continuous line; we call

## EDUCATIONAL DEVELOPMENT OF CHILDREN

such a scale of variability a continuum. But it is impossible to fix the position on the continuum of the attitude of one person with any degree of accuracy. Fortunately, such precision is not necessary, for our measurements need only be accurate enough for the job in hand. There is nothing to worry about if our load of coal is a pound under weight, but if we are dealing with gold, an ounce is a considerable matter. When we are measuring heights, it is usual to make half an inch the unit, and this suffices for most practical purposes; but it is conceivable that on occasions we may demand greater accuracy and measure to the nearest quarter of an inch.<sup>1</sup> When we wish to provide our boys and girls with school desks we do not measure each boy and girl accurately and then make the desks "to measure", ensuring that the desk-top is at the correct height, that the seat is so fixed that each child's feet are comfortably placed on the floor, and that there is sufficient space for his knees between the seat and the top of the desk. This would be ridiculous, for, to take only one reason, by the time the desks had been manufactured, the boys and girls would have grown—each probably a different amount from the other—and, in consequence, the desks would be misfits. In this instance it is sufficient to make the desks in several standard sizes.

It is important, therefore, to choose a unit of measurement suitable for the assessment we are making; but it should be as accurate as possible. When we are dealing with qualities of disposition, it is possible to indicate only in which fifth of the continuum the child's position lies, hence the use of the five-point scale (see p. 36). At the present day, too, these measurements can be only as accurate as an assessment can be. We can measure what is called general mental ability with much greater

<sup>1</sup> This was done in the original regulation for the award of extra clothing coupons to school children.

## ELEMENTARY STATISTICS

accuracy ; for tests have been devised which will enable us to calculate a score which will represent the pupil's standard of intelligence. (See Chapter IV, p. 77.) But here again we must be careful, for the I.Q.<sup>1</sup> can only be an approximation, since the score may have been interfered with by the environmental conditions under which the test was applied.

The completed record card may show several kinds of measurements ranging from the more precise date of birth to the rating of sociability on a five-point scale and to the very indefinite remark that the child is "lazy" or "inclined to be careless".

### FREQUENCY DISTRIBUTIONS

Let us suppose that the teacher is faced with the problem of teaching arithmetic to a class of forty pupils. He will realize that there is considerable variation in ability and in attainment ranging from the best pupil to the worst. The ideal method would be to teach each child individually, but in a class of forty this is impossible. He decides to group the children into a number of sets, so that he can teach them according to their attainment in the subject.

For this purpose he sets the class an attainment test, though sometimes he will be able to extract the information from the record cards. He will then distribute the marks gained by the boys and girls along a continuum ranging from the highest mark to the lowest. The simplest way to do this is to make a list of marks in order as in Table 1, and against each to put a tally (or stroke) for each person who gains the mark. When dealing with a large number of persons it is best to draw each fifth tally across the previous four ; the grouping in fives makes

<sup>1</sup> I.Q., Intelligence Quotient, that is the ratio between mental age and chronological age : see p. 77.

## EDUCATIONAL DEVELOPMENT OF CHILDREN

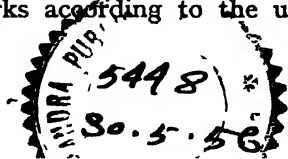
counting easy. From this table we can see how the marks are distributed and the frequency with which each mark occurs; it is therefore called a frequency distribution. In Table 1 is given the actual marks gained in a local authority's test by a class of girls received into a modern secondary school at the age of 11+. (The mean or average mark for all children in the Authority is 100.)

**TABLE 1**  
*Distribution of Marks Gained in Arithmetic by a Class of Girls*

Marks	Indices	Frequency Totals
110	I	1
109	—	—
108	—	—
107	—	—
106	—	—
105	II	2
104	III	3
103	III	3
102	IIII	5
101	IIII	4
100	IIII	5
99	IIII	4
98	IIII	4
97	III	3
96	II	2
95	II	2
94	II	2
Total Cases	40	40

After the record card of the child with 110 marks had been re-examined it was found that she had been placed in the wrong class. Accordingly, arrangements were made for her to be transferred to a more suitable environment.

From this table we can arrange the thirty-nine children remaining into the number of groups we wish to take. In actual practice we should probably not distribute the marks according to the unit of measurement, for that



# ELEMENTARY STATISTICS

often gives us a lengthy table, but we should distribute them according to "space-" or "step-intervals", each consisting of a number of consecutive units. The class represented in Table 1 has been re-distributed in Table 2 using the space-interval of three marks. This distribution gives us five groups of children.

TABLE 2

*Distribution, using a Space-interval of Three Marks, of Marks Gained in Arithmetic by a Class of Girls*

Marks	Tallies	Frequency Totals
104 to 106		5
101 to 103		12
98 to 100		13
95 to 97		7
92 to 94		2
Total Cases	39	39

A distribution may be expressed vividly by means of what is called a histogram or by a frequency polygon. (See Fig. 1.) Along the X-axis are marked off equal distances, each of which represents one space-interval in the frequency distribution; along the Y-axis is measured the number of cases of marks occurring in that space-interval; the rectangles are then drawn in to represent the distribution, as in Fig. 1. These histograms are frequently used in newspapers to represent variables in a vivid manner. From Fig. 1 we can easily and quickly perceive that there are twelve children who obtained marks between 101 and 103.

If the number of space-intervals is sufficiently large it is usually better to represent the distribution graphically by a series of points, which joined together form a frequency polygon, or, in more familiar terms, a graph. The curve

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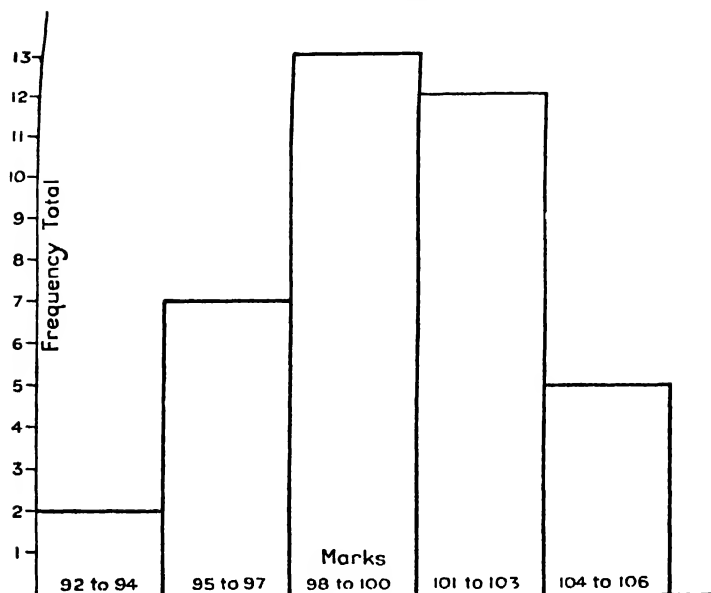


FIG. 1.—HISTOGRAM SHOWING DISTRIBUTION OF MARKS IN  
TABLE 2

joining the points is known as a distribution curve. When the population examined or tested or assessed is a large one, then, according to the "law of averages", the curve will gradually rise and fall symmetrically around the highest frequency; that is there will be 50 per cent. of the population distributed above the average mark and 50 per cent. distributed below the average mark. Such a curve is called the normal curve of error, the Gaussian curve, or the normal probability curve (see Fig. 2). It is the type of curve obtained by graphing any simple variant found in nature distributed by chance or "the law of averages".

It is sometimes more useful to add the frequencies of the scores cumulatively. For instance, Table 3 shows the

## ELEMENTARY STATISTICS

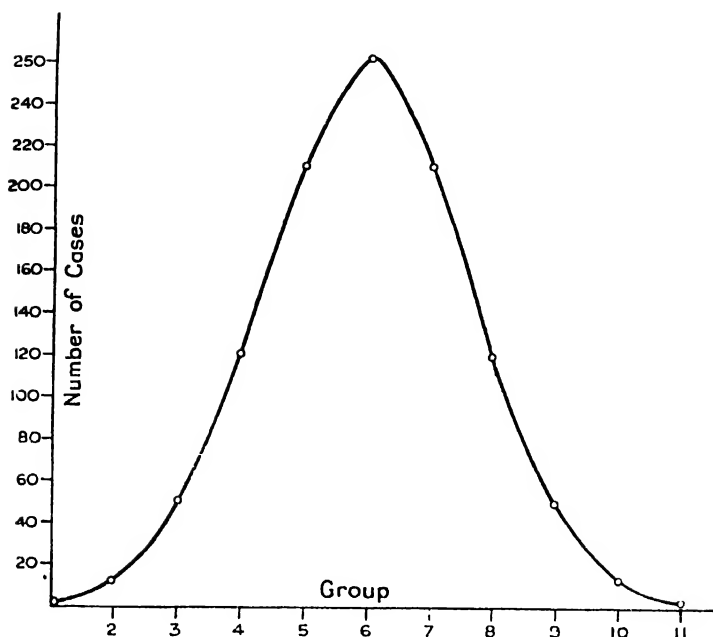


FIG. 2. THE NORMAL CURVE OF DISTRIBUTION

frequencies and cumulative frequencies of the marks distributed in Table 1. There are two cases with 94 marks and two with 95, so that "cumulatively" there are four cases in the interval 94-95. Similarly there are nine cases cumulating with marks of 94, 95, 96, 97. The value of adding the results cumulatively is that it enables us to see at a glance how many cases are above or below a certain space-interval. The table shows that twenty-two girls had marks of 100 or below and seventeen had marks above this measure.

Sometimes these cumulative frequencies are calculated as decimal fractions of the total number of cases, and then



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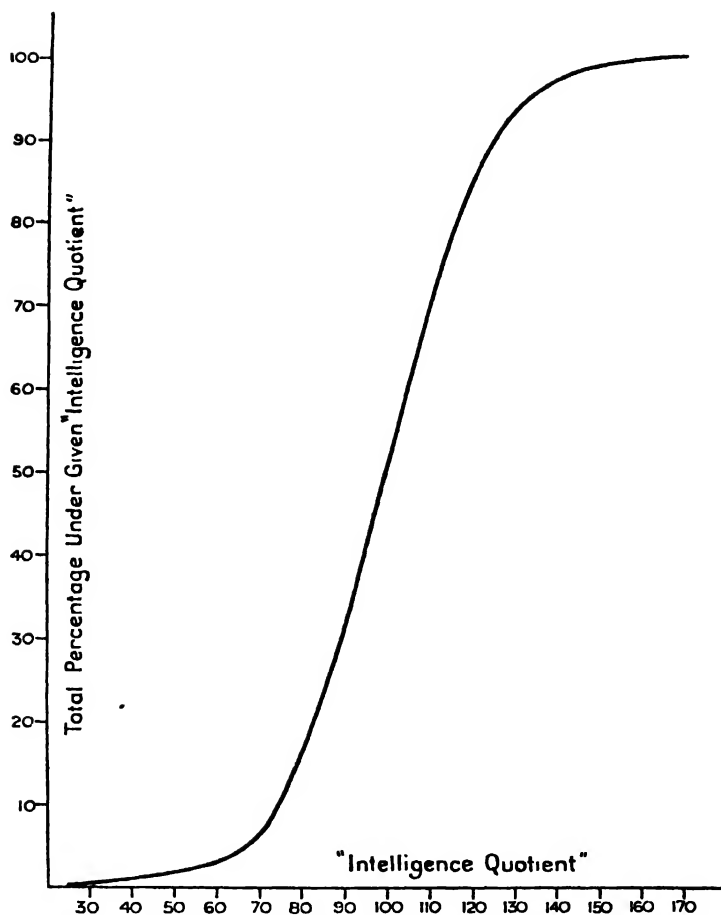


FIG. 3—CUMULATIVE FREQUENCY CURVE

they are called "cumulative proportions". For ease in working they are often multiplied by 100 and thus changed into "cumulative percentages". Fig. 3 shows the graph of a cumulative distribution.

# ELEMENTARY STATISTICS

## TABLE 3

*Cumulative Frequencies of Marks Distributed in Table 1*

Marks.	Frequencies.	Cumulative Frequencies.	Cumulative Percentages.
105	2	39	100.0
104	3	37	94.9
103	3	34	87.2
102	5	31	79.5
101	4	26	66.7
100	5	22	56.4
99	4	17	43.6
98	4	13	33.3
97	3	9	23.1
96	2	6	15.4
95	2	4	10.2
94	2	2	5.1

## PROBABILITY

Suppose we toss a coin. There is an even chance that it will come down head and an even chance that it will come down tail—that is, the chances of head to tail are 1 to 1. Now, if we toss the coin a few times, it may come down heads more frequently than it does tails, or vice versa. But if we toss the coin a sufficient number of times, then we shall find them in the ratio of one head to one tail.

Now, suppose we toss two pennies. They may show a variety of arrangement; two heads, one tail and one head, one head and one tail, or two tails; that is the chances are 1 in 4 that they will both be heads; 2 in 4 will be one head and one tail, and 1 in 4 will be two tails. If they are tossed up 1000 times, the probability is that 250 cases will show two heads, 500 cases a head and a tail, and 250 cases two tails, because there are two chances of the pennies showing one head and one tail to every chance of their showing two heads or two tails. Actually two pennies show a slight variation from the normal, such as 248, 501, 251. The more times the experiment is



the curve will be to the theoretical normal curve. The curve in Fig. 2 is that of the expansion of  $2^{10}$ .

The value of this curve to us lies in the fact that, so far as we are aware at the moment, human qualities and characteristics are distributed by chance according to this curve. Consequently, if we take any particular item on the children's records, and obtain such a curve for a sufficient number of assessments or measurements, we may assume that, in general, the assessments have been made carefully and accurately.

Again, when we come to measure a group of children, we should remember that the larger the number of cases in the group—that is, the larger the population—the greater is the probability that the distribution will resemble the normal probability curve. Secondly, the distributions are likely to be more normal if the group of children is a "random sample". By "sample", statisticians imply that we are taking a group of cases to represent the large population necessary to give the distribution of the normal curve; by "random", they indicate that the group is so chosen that it is representative of the total population and that there has been no selection of the cases other than by chance or "at random".

In schools we are likely to meet with several common variations of the normal distribution curve, which arise generally because the samples are not chosen at random. For instance, if we had a group of children composed of the brightest stream and the backward stream of a school, and we drew the graph of the distribution of their arithmetical ability, we should have a curve with two apices or bumps in it. This is called a Bimodal Curve (see Fig. 4).

Such a curve nearly always points to a mixture of two distributions or the omission of a group. But such an assumption cannot be made unless the sample is large enough. If we obtained such a curve for a class of forty,

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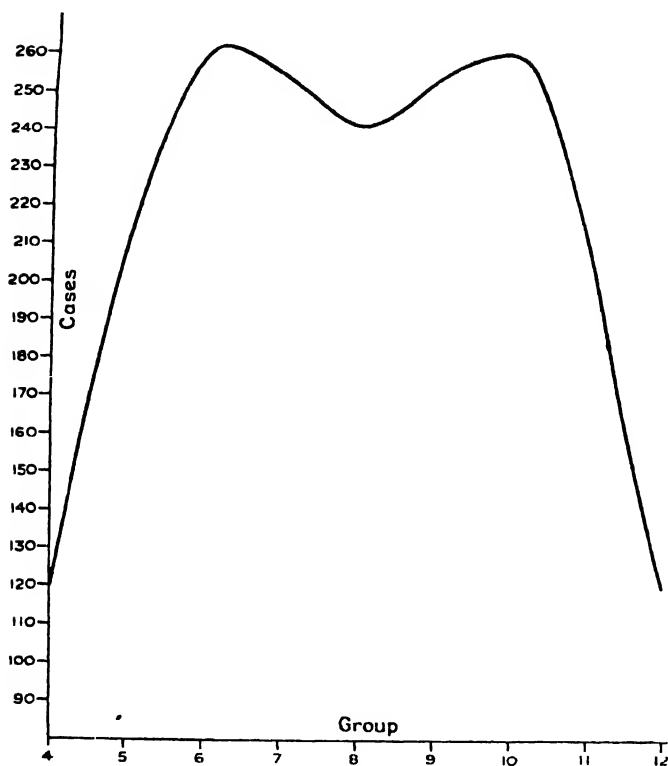


FIG 4 —A BIMODAL CURVE

it would prove nothing; if we obtained it for the 600 children in a school, it would be worth investigating; if it occurred in 25,000 children, we should be quite safe in assuming that we had two distinct variables—for example, the heights of boys and those of girls.

Again, suppose all the children under a local authority are examined, and the top 15 per cent, except those whose parents have asked for the child's education to be continued in a modern secondary school, are sent to the

# ELEMENTARY STATISTICS

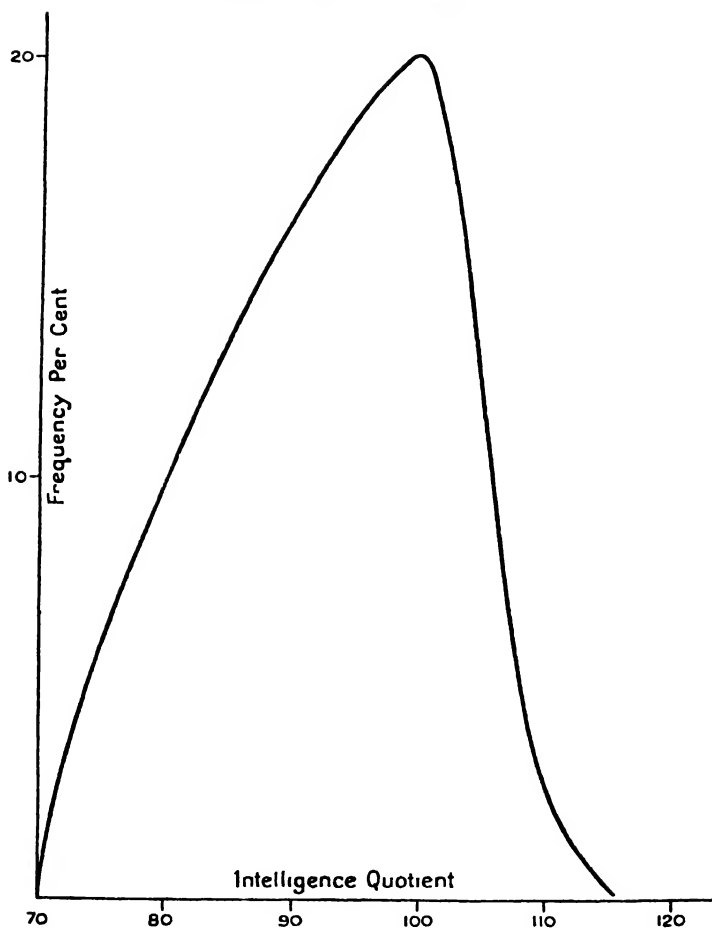


FIG. 5.—SKEW CURVE—POSITIVELY SKEWED

grammar and technical secondary schools. If we draw the graph of the distribution of the I.Q.'s of the remainder, we should obtain a curve as in Fig. 5, for there would be few cases of high scores. The curve is said to be "skewed".

## EDUCATIONAL DEVELOPMENT OF CHILDREN

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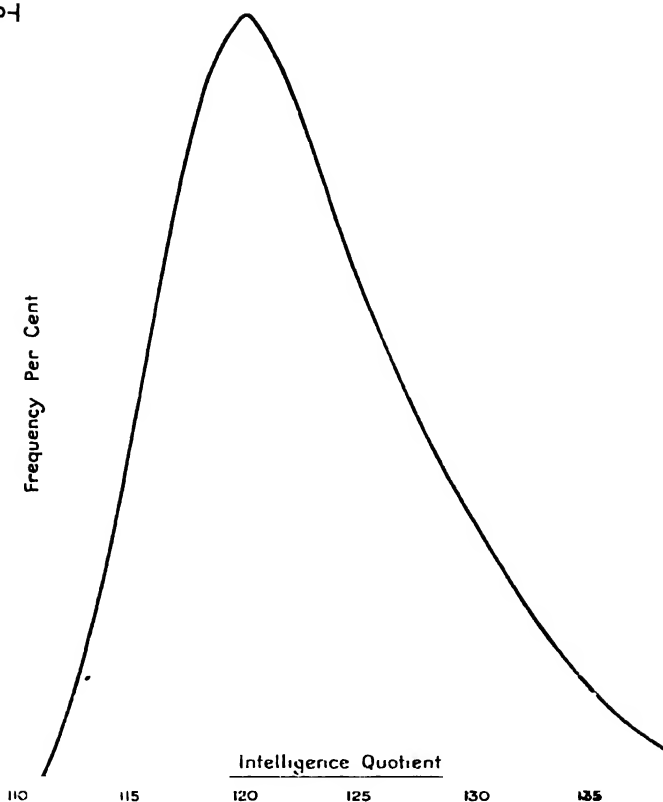


FIG. 6. —SKEW CURVE—NEGATIVELY SKEWED

Similarly, if we graph the 15 per cent of the children who go to the grammar and technical secondary schools, the children with the lowest marks will be missing, and we should obtain the graph shown in Fig. 6.

It should be emphasized that such curves point to the operation of some causative factor acting on the chance distribution.

## ELEMENTARY STATISTICS

### AVERAGES

Let us return to the general attainment of our class. In order to express this, we need to have two numbers: first, the average or mean mark <sup>1</sup> and second an indication of how much in general the pupils of the class deviate from the average—for two classes may have the same mean mark, but one may have a much greater range of marks than the other. For instance, in the two series 30, 50, 70, and 45, 50, 55 the mean is 50, but the range in the first series is 40 and in the second 10. The variation may be measured in several ways. The simplest way of representing it is to state the range of the measures—that is, to subtract the lowest score from the highest to show over how wide a field the measures are “spread” or “scattered”. Thus if the highest mark is 93 and the lowest 32, the range is 61 marks. Sometimes it is better to use the Quartile Deviation ( $Q$ ).  $Q$  is half the distance between the measures representing 25 per cent and 75 per cent of the population; so that  $2Q$  represents the middle 50 per cent of the population. The 25th and 75th percentile points are called  $Q_1$  and  $Q_3$ : the quartile points.<sup>2</sup> If  $Q$  is large, the original measures are widely scattered; if it is small, the measures are close together. When the percentile point occurs within a space interval, then the quartile point is calculated as follows. If there are 304 measures, then  $Q_1$  will fall at the  $\frac{304}{4} = 76$ th measure.

If we have seventy-three measures below the interval 30–34, then  $Q_1$  will fall at the 3rd measure within that

<sup>1</sup> This measure is calculated by adding the marks of all the pupils and dividing the total by the number of pupils, or, in more technical language, the mean or average is found by dividing the sum of the series by the number of cases.

<sup>2</sup>  $Q_2$ , the 50th percentile, is usually called the median. More simply the median is the central measure in the distribution.



## EDUCATIONAL DEVELOPMENT OF CHILDREN

interval. If there are six measures within the interval, then  $Q_1$  will fall at  $3/6$ th of the space-interval—that is, at  $3/6$ th of 5 marks, above the previous interval, 25–29. For the purpose of calculation it is usual to take a point midway between the two space-intervals as the point of division between the intervals. In this instance it will be 29.5. Then  $Q_1 = 29.5 + (3/6 \times 5) = 32.0$ .

A more reliable measure of variation, known as the “mean variation”, is found by subtracting the mean from the individual scores, summing these differences (neglecting the signs), and dividing by the total number of cases. It is the mean of the deviations (differences) from the mean. In the example given earlier (see Table 1), if we neglect the pupil with a mark of 110, we find that the mean is 100, and the sum of the differences of the individual scores from the mean is 96, which gives a mean variation for the thirty-nine cases of 2.46. We should therefore expect the majority of the pupils to be within 3 marks of the mean—that is, between the marks 97 and 103 (*i.e.*,  $100 \pm 3$ ). Actually twenty-eight out of the thirty-nine do lie in this range.

Obviously the smaller the mean variation the less widely are the pupils distributed. Table 4 represents five children who were examined in Arithmetic, English, and Mental Ability. The mean is the same in each subject, but the mean variations show that there is a wider range in English and Arithmetic than in mental ability. When the cases are few, as in this example, this knowledge can be deduced from the table or from the distribution curves. But a calculated measure of variation is useful for a larger number of cases.

Actually the mean variation is little used in statistics, although from the point of view of the class teacher it is the easiest measure of distribution to calculate. In all full analyses of variation, however, the more usual method of

# ELEMENTARY STATISTICS

## TABLE 4

*Table showing the Calculation of the Mean Variation*

Pupil.	Mental Ability		Arithmetic		English	
	Marks	D (— difference)	Marks	D	Marks	D
A	101	1	107	7	116	16
B	99	1	102	2	97	3
C	98	2	91	9	102	2
D	102	2	104	4	85	15
E	100	0	96	4	100	0
Mean	100	—	100	—	100	—
Mean Variation <sup>1</sup>		$\frac{1}{5}$ 1 2		$\frac{1}{5}$ 5 2		$\frac{1}{5}$ 7 2

$\left[ \text{M V } \frac{\sum d}{N} \right]$   $\Sigma$  is used to mean "the sum of",  $d$  = difference or deviation  $N$  = number of cases

measuring the distribution is by means of the Standard Deviation, represented by the Greek letter  $\sigma$  (sigma). To calculate this measure the deviations from the mean are squared before they are added. The sum of the squares is then divided by the number of cases, and the square root is extracted.

$$\sigma = \sqrt{\frac{\sum d^2}{N}} = \sqrt{\frac{\text{sum of the squared differences}}{\text{Number of cases}}}$$

Table 5 shows the method of calculating  $\sigma$  from the sample given in Table 4. There are shortened methods of calculating this measure, but, as they require greater mathematical competence, we have omitted them.

In general, the standard deviation is greater than the mean deviation, since greater weight is given to the extreme deviations from the mean. In the normal curve of distribution, the mean variation includes about one-seventh of the total range, whereas the standard deviation includes one-sixth. In other words, if the distribution is

# EDUCATIONAL DEVELOPMENT OF CHILDREN

TABLE 5

## *The Calculation of the Standard Deviation*

Pupil	Mental Ability			Arithmetic			English		
	Marks	D	D <sup>2</sup>	Marks	D	D <sup>2</sup>	Marks	D	D <sup>2</sup>
A	101	+1	1	107	+7	49	116	+16	256
B	99	-1	1	102	+2	4	97	-3	9
C	98	-2	4	91	-9	81	102	+2	4
D	102	+2	4	104	+4	16	85	-15	225
E	100	0	0	96	-4	16	100	0	0
Mean	100		10	100		106	100		494
$\Sigma D^2$									
$\sigma = \sqrt{\frac{\Sigma D^2}{N}}$	$\sigma = \sqrt{\frac{10}{5}}$ 1.41	$\sqrt{2}$		$\sigma = \sqrt{\frac{106}{5}}$ 4.62	$\sqrt{21.2}$		$\sigma = \sqrt{\frac{494}{5}}$ 9.94	$\sqrt{98.8}$	

normal, then  $6\sigma$  will cover practically all the cases. In actual practice the range of any sample is usually covered by from  $5\sigma$  to  $7\sigma$ , owing to samples not being chosen at random, or to inaccuracies in the measurements. If the curve falls outside these limits, the sample should be neglected, as the errors are too large.

The standard deviation is of great value in calculating the theoretical normal curve of the distribution of any quality or characteristic in nature. The equation <sup>1</sup> from which such a curve is plotted is

$$y = \frac{e^{-\frac{x^2}{2\sigma^2}}}{\sigma\sqrt{2\pi}}$$

where  $x$  represents the scores expressed as deviations from the mean,  $y$  the frequency with which these scores occur,  $e$  is 2.7183 (the basis of Napierian logarithms),  $\pi$  the ratio

<sup>1</sup> Many teachers will find this formula too difficult to use. The calculation may be made more easily if the graphs and tables compiled by statisticians are used. See p. 52.

of the circumference of a circle to the diameter = 3.1416, and  $\sigma$  the standard deviation from the mean of the distribution. If against the varying values of  $x$  we plot the corresponding values of  $y$ , the result will be a normal curve of distribution. This means that if we know the standard deviation, we can find  $y$  for any value of  $x$ —that is, we can find the frequency of every possible measure. Consequently, provided that the distribution is normal, we can quickly determine what proportion of the population has a certain measure (e.g., of height, or weight, or intelligence), what proportion lies between two measures, and what proportion is above or below a certain measure.

For the class teacher it is useful to know some of these proportions. For instance, it is suggested that 15 per cent of an age-group are suitable for education in a grammar or technical school. This is based upon the assumption that scores which differ from the mean by more than  $1\sigma$  are above or below normal. In the normal probability curve  $1\sigma$  covers 34.13 per cent of the population, when it is measured from the middle point of the distribution. So that if we take along the base line a distance  $1\sigma$  on either side of the mean, it will include 68.26 per cent (roughly two-thirds) of the population. This leaves 31.74 per cent who are equally divided above and below normal—i.e., 15.87 per cent of children are above normal and 15.87 per cent below. For practical purposes 15 per cent is taken as the upper limit. At the lower end of the scale 10 per cent is suggested as the proportion of the children who should be classified as below normal, since in some respects this may carry a social stigma, as, for example, when children are classified as dull and backward.

Having found the proportions of children to be classified, it is then possible to locate them on the scale. If we have tested intelligence, then we shall find that 15 per cent of

## EDUCATIONAL DEVELOPMENT OF CHILDREN

the population can be expected to have an I.Q. greater than 116.5, and another 15 per cent an I.Q. of less than 83.5; 10 per cent can be expected to be greater than 121, and another 10 per cent less than 79; and 5 per cent greater than 127 and another 5 per cent less than 72.<sup>1</sup>

If we refer back to our triangle of figures showing expansions of  $(1 + 1)^n$  which represent the normal curve, we shall find one expansion which is quite useful, for it gives us the basis of our five-point scale. This expansion is 1, 4, 6, 4, 1. This means that we can expect one of sixteen measures to be in class A if the distribution is normal, four of sixteen in B, six in C, four in D, one in E. If we represent this in percentages, the expansion becomes  $6\frac{1}{4}$ , 25,  $37\frac{1}{4}$ , 25,  $6\frac{1}{4}$  per cent. For ease in working and for other reasons (such as giving advantage to the border line cases in Class E) these are taken as 5, 25, 40, 25, 5 per cent. It is useful, therefore, to know the scores which are likely to be obtained by these proportions of our populations. They are given, therefore, in Table 6. The scores given are Standard Scores, which are calculated with a mean of 100.

TABLE 6  
*Showing the Normal Distribution of Standard Scores*

Class	% of Population of same Age and Sex	Standard Score
A	Top 5	Over 127
B	Next 25	110 to 126
C	Middle 40	92 to 109
D	Next 25	74 to 91
E	Lowest 5	73 or less

Standard Deviation = 16.5

<sup>1</sup> These proportions of the whole distribution may be calculated by the use of the graph given in Fig. 9. Vernon suggests ("The Measurement of Abilities," p. 89) that the mean of the distribution is 100 and  $\sigma$  is 16.5.

## ELEMENTARY STATISTICS

### STANDARD SCORES

After we have marked a school examination we often wish to compare the performances of our pupils in different subjects, and to compare or arrange in order their performances in the examination as a whole. The usual method is to make the maximum mark of each paper 100, to add together the individual's marks in each subject and to base our comparisons on the aggregate score. This method may be quite unreliable. Let us take the case of a child who scores 50 on each of two papers. The mean mark for the first paper is 65, and the marks of the pupils are distributed over a range of 70 marks, from 30 to 100. The second paper was more difficult and, although there was an equally wide range of marks, it was spread over marks 1 to 70, and the average mark was only 38. The child's performances in these two papers, although gaining the same numerical award, are obviously of different standards; in the first he was well below average, and in the second he was well above it. To add his raw scores will very probably give a wrong indication of his general performance. It would be better to add the child's positions in the class in the various subjects and to derive our final order from this. This procedure is more reliable, but still crude; for it takes no account of the size of the gaps in the range of marks, of the variability within the series, or the form of the distribution, it is best used only when scores are too few or too scattered to justify the use of a more precise method. The best method is to use what are known as standard scores.<sup>1</sup>

These are so calculated that scores in all subjects may be added, subtracted, or averaged, and direct comparisons may be made. They take a little time to calculate, but the work is easy. With the help of logarithms, or, better

<sup>1</sup> The symbol for "standard score" is " $z$ ".

# EDUCATIONAL DEVELOPMENT OF CHILDREN

still, of a slide rule, the operations can be performed reasonably quickly.

To calculate a standard score we must first find the mean mark ( $M$ ) of the population—in this instance, the class. Next we find how much each individual score ( $S$ ) deviates from the mean. From this we calculate the standard deviation ( $\sigma$ ) for the class. Then  $z = \frac{S - M}{\sigma}$ . Table 7 shows the calculation for one subject, Arithmetic, for a group of ten children, and Table 8 a comparative table of five subjects for one child. In these calculations we make

TABLE 7

*The Calculation of Standard Scores for Ten Children in One Subject*

Child	Marks	$d = S - M$	$d^2 = (S - M)^2$	$z = \frac{S - M}{\sigma}$
A	10	- 33	1089	1.94
B	42	- 1	1	- 0.06
C	50	+ 7	49	+ 0.41
D	61	+ 18	324	+ 1.06
E	36	- 7	49	- 0.41
F	55	+ 12	144	+ 0.71
G	42	- 1	1	0.06
H	67	+ 24	576	+ 1.41
I	18	- 25	625	- 1.47
J	49	+ 6	36	+ 0.35
Mean	43		$\Sigma d^2 = 2894$	

$$\sigma = \sqrt{\frac{\Sigma (S - M)^2}{N}} = \sqrt{\frac{2894}{10}} = 17.$$

two basic assumptions : that the scores from the different tests are distributed approximately normally, and that the standard scores ( $z$ ) in one test indicate the same degrees of superiority as do standard scores in another test. But these are the assumptions made in the construction of the tests and in consequence they should prove true when the

# ELEMENTARY STATISTICS

tests are applied. The materials of the tests are so manipulated that they will give results which show normal distributions, and which have the same mean (100) and the same  $\sigma$ . The testers begin with the assumption that a sufficiently large population will, by the law of averages, give results which show a normal distribution.<sup>1</sup>

TABLE 8

*The Calculation of Standard Scores in Several Subjects of One Child*

	English	Art	Arithmetic	Geography.	Science
Score	62	55	67	40	65
Mean	55	42	61	50	38
$S - M$	7	13	6	-10	27
$\sigma$	10	12	10	15	9
$z = \frac{S - M}{\sigma}$	0.54	1.08	0.60	-0.66	3.00

Mean standard score  $5.22 - 0.66 \times \frac{4.56}{5} = 0.91$

The test is applied to a large population of children and, in the light of the results obtained, is modified until results are obtained which, when plotted, do not deviate significantly from the normal curve. We are justified, therefore, when in our calculations we make the assumptions mentioned at the beginning of the paragraph.

## THE "100" SCALE

Since these standard scores are often small, sometimes negative and always inconvenient to handle, it is usual to convert the raw scores to a scale in which the mean and  $\sigma$  have previously assigned values. C. L. Hull<sup>2</sup> devised a scheme by means of which raw scores in any distribution may be converted into standard scores with a mean of 50

<sup>1</sup> In considering any standard test—for example, an Intelligence Test—we must bear in mind that it has been constructed in this way. We arrange the results so that they prove the hypothesis.

<sup>2</sup> *Journal of Applied Psychology*, 1922, 6, 298-300



# EDUCATIONAL DEVELOPMENT OF CHILDREN

and a range of 100, and (assuming that  $7\sigma$  would cover the range) a standard deviation of 14. The equation used by

Hull is  $z = 50 + \frac{14}{\sigma} (S - M)$ , where  $z$  is the standard score,  $S$  is the individual's raw score,  $M$  the mean of the distribution, and  $\sigma$  is the standard deviation of the sample.

Since the I.Q. is usually represented as having a mean value of 100, scales are usually put on this basis by doubling  $z$ . In Tables 9 and 10 are illustrated the calculations of  $z$  and  $2z$  for a series of marks in Arithmetic, English, and Science.

Such tables of Standard Scores are composed when children are examined for selection for secondary education, so that the marks for English, Arithmetic, and Intelligence can be added. It would be better if all school tests of attainment in which an aggregate mark is required were finally assessed on standard scores with a mean of 100. We shall consider this more fully in the chapter on educational attainment.

TABLE 9

*The Calculation of Standard Scores with a Mean Mark of 100*

*Arithmetic*

Child	Marks	$d$	$d^2$	$z$	$2z$
A	10	- 33	1089	23	46
B	42	- 1	1	49	98
C	50	+ 7	49	56	112
D	61	+ 18	324	65	130
E	36	- 7	49	44	88
F	55	+ 12	144	60	120
G	42	- 1	1	49	98
H	67	+ 24	576	70	140
I	18	- 25	625	29	58
J	49	+ 6	36	55	110
Mean	43	$\sigma = \sqrt{\frac{\sum d^2}{N}} = \sqrt{\frac{2894}{10}}$			17

# ELEMENTARY STATISTICS

## *English*

Child.	Marks.	<i>d.</i>	<i>d</i> <sup>2</sup>	<i>z.</i>	<i>2z.</i>
A	14	-28	784	22	44
B	39	- 3	9	47	94
C	47	+ 5	25	55	110
D	50	+ 8	64	58	116
E	40	- 2	4	48	96
F	62	+20	400	70	140
G	36	- 6	36	44	88
H	55	+13	169	63	126
I	23	-19	361	31	62
J	54	+12	144	62	124
Mean	42	$\sigma = \sqrt{\frac{\sum d^2}{N}} = \sqrt{\frac{1996}{10}} = 14.1$			

## *Science*

Child.	Marks.	<i>d</i>	<i>d</i> <sup>2</sup>	<i>z.</i>	<i>2z.</i>
A	17	27	729	23	46
B	40	- 4	16	46	92
C	54	+10	100	60	120
D	47	- 3	9	53	106
E	43	- 1	1	49	98
F	70	+26	676	76	152
G	41	- 3	9	47	94
H	51	+ 7	49	57	114
I	27	-17	289	33	66
J	50	+ 6	36	56	112
Mean	44	$\sigma = \sqrt{\frac{\sum d^2}{N}} = \sqrt{\frac{1914}{10}} = 13.8$			

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TABLE 10

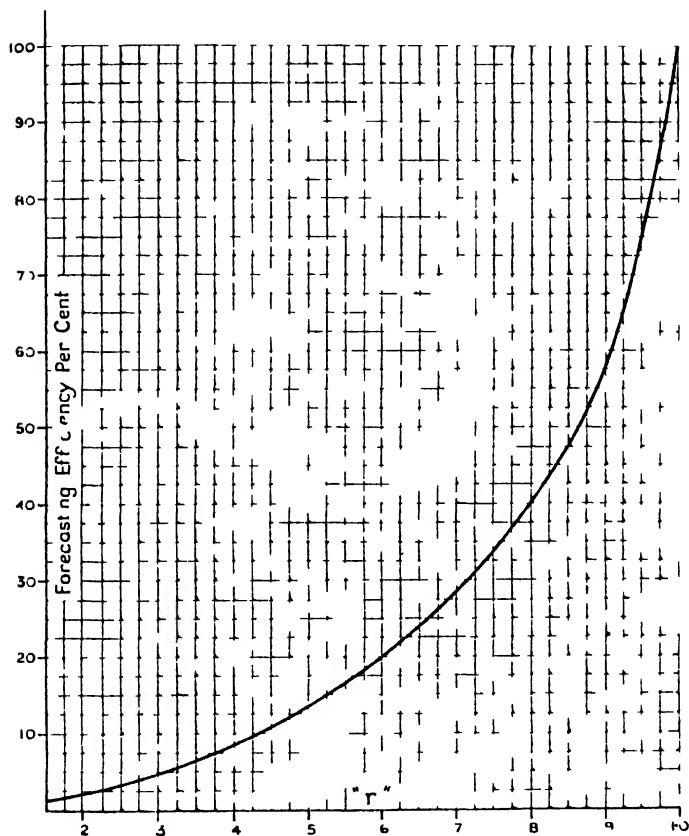
*Combined Standard Scores and Final Order*

	Arith- metic.	English.	Science	Mean	Order.
A	46	44	46	45	10
B	98	94	92	95	6
C	112	110	120	114	5
D	130	116	106	117	3
E	88	96	98	94	7
F	120	140	132	137	1
G	98	88	94	93	8
H	140	126	114	127	2
I	60	62	66	63	9
J	110	124	112	115	4

## CORRELATION

Most of us are familiar with the fact that to a certain extent pupils who are good at one subject will be good at a similar subject. Boys and girls who are capable at French usually do well at German; those who manage Arithmetic successfully can also manage Algebra. There seems to be some relationship between performances in the subjects, which indicates that ability in one will be related to ability in another. At the same time, a boy who is good at science may not do good work in the arts, or in subjects requiring manual dexterity. Again, there are children who do well at most intellectual pursuits and those who appear equally incapable of making much progress in any subject. If we examine the class lists of marks, or of orders in tests, we shall see clearly these partial agreements. When any two or more series are related in this way they are said to be correlated. It is often important to be able to measure the degree of agreement or disagreement, therefore statisticians have

# FLLMENARY STATISTICS



11-7 To Obtain Forecasting Efficiency as a Percentage Guess Better than Chance when  $r$  is Known

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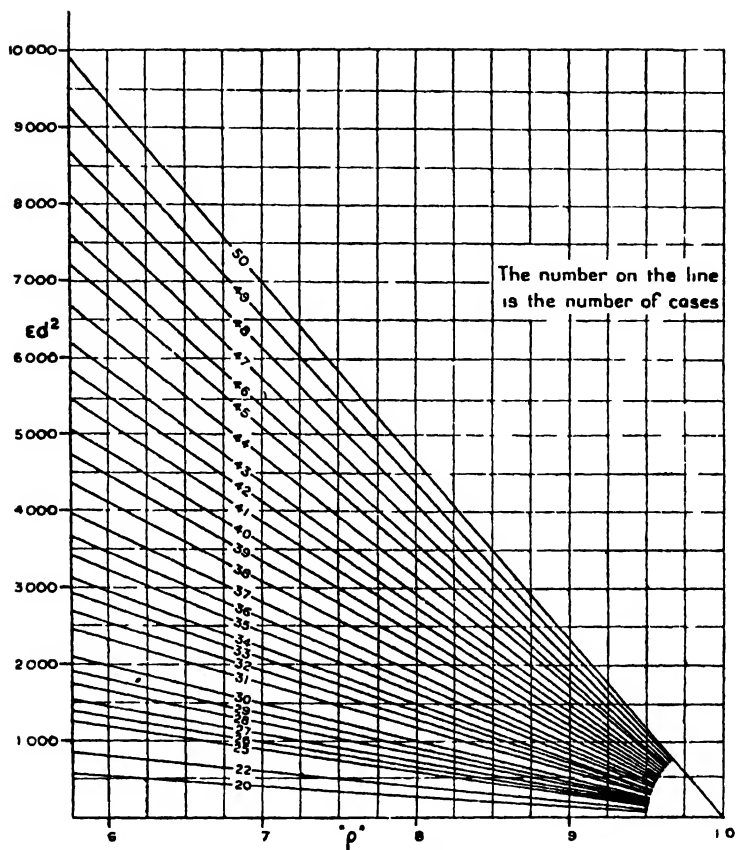


FIG 8 —To OBTAIN " $\rho$ " IF  $\Sigma d^2$  AND N ARE KNOWN FROM RANK FORMULA

devised a number of methods for calculating the "coefficient of correlation" or " $r$ ".

The fraction " $r$ " is so chosen that if the two lists were exactly alike—that is, if the top of one list was the top of the second, the second on the first list was second on the other, and so on—it would be  $+1.00$ , and we should say that there was perfect correlation. If there were perfect inverse correlation—that is, the top boy in one list was the bottom in the other and so on— $r$  would be  $-1.00$ . A correlation of  $+0.60$  indicates that there is some similarity between the two lists, but that they are not identical. When  $r = +0.80$  the lists are much nearer being identical. A coefficient of  $-0.80$  would indicate that the lists, though markedly inclined to be topsy-turvy, are not completely so. If  $r$  is zero, it indicates that there is no correlation between the lists—that is, that there is no tendency to similarity or to dissimilarity. In this last instance it is impossible to predict from a child's performance in one subject his probable performance in the other, whereas in the other instances, where we have a positive or negative correlation, it is possible to predict, with varying degrees of accuracy, according as the coefficient approaches  $\pm 1.00$ , the performance in the second subject from the performance in the first.

A table has been devised to give a measure of how much more accurate will be a deduction from a known correlation coefficient than will be a pure chance guess. Table 11 shows the forecasting efficiency for any value of  $r$ , and the same data are represented graphically in Fig. 7. Both the Table and the graph show that where correlation between algebra and arithmetic is  $+0.94$ , a guess at a child's ability at algebra, given his ability at arithmetic, would be about 68 per cent more accurate than a chance guess.

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TABLE 11

*Table Showing the Forecasting Efficiency of  $r$*

$r$	0	0.1	0.2	0.3	0.4	0.5
% F E	0	0.5	2.0	4.6	8.4	13.4
$r$	0.6	0.7	0.8	0.9	0.95	1.0
% F E	20.0	28.6	40.0	57.5	75.0	100

Garrett <sup>1</sup> gives the following table for interpreting the correlation coefficient.

0.00 to  $\pm 0.20$  indifferent or negligible relation.

$\pm 0.20$  to  $\pm 0.40$  low correlation : present but slight.

$\pm 0.40$  to  $\pm 0.70$  substantial or marked relationship.

$\pm 0.70$  to  $\pm 1.00$  high relation.

## THE RANK ORDER COEFFICIENT OF CORRELATION

The simplest way of calculating a coefficient of correlation is that known as the rank order coefficient of correlation. This does not give us the exact value of  $r$ , but it is sufficiently accurate for all normal purposes, especially when the number of cases is not more than fifty. To indicate this approximate value of the coefficient we use  $\rho$  (rho) and keep  $r$  for the exact value. Table 12 shows how such a calculation may be made. The children are arranged in rank order in each list. When two pupils have the same mark the order is taken at half-way between the two orders. The difference ( $d$ ) between each boy's rank in the two subjects is found and then squared ( $d^2$ ). From the sum of the squares of the differences ( $\Sigma d^2$ ) and the number of pupils in the class ( $N$ ), the correlation coefficient can be found by substitution in the formula :

$$\rho = 1 - \frac{6\Sigma d^2}{N(N^2 - 1)}$$

<sup>1</sup> "Statistics in Psychology and Education," p. 342.

# ELEMENTARY STATISTICS

## TABLE 12

*Table Showing the Calculation of a Rank Order Coefficient of Correlation*

Child.	Arith- metic Marks	Algebra Marks.	Arith- metic Order	Algebra Order.	$d$ .	$d^2$ .
A	70	68	3.5	2	1.5	2.25
B	74	64	2	3	1.0	1
C	36	32	11	11		
D	56	47	5	8	3.0	9
E	25	21	12	12	-	-
F	92	87	1	1		
G	70	52	3.5	5	1.5	2.25
H	46	40	9	9.5	0.5	0.25
I	20	9	13	14	1.0	1
J	11	12	14	13	1.0	1
K	3	40	10	9.5	0.5	0.25
L	52	50	6	6.5	0.5	0.25
M	49	54	7	4	3.0	9
N	48	50	8	6.5	1.5	2.25
	$N$	14	$N^2$	196.	$\Sigma d^2$	28.5.
	$\therefore \rho$	1	$\frac{6 \times 28.5}{14 \times 195}$	- 1	0.06	0.94.

In order to help the teacher to calculate rank correlations for his daily work, a graph by which  $\Sigma d^2$  can be converted into  $\rho$  is given (see Fig. 8). Suppose, for example, we wish to find the correlation between the geography and arithmetic marks of thirty-four pupils, and we have calculated  $\Sigma d^2 = 2000$ . On the  $y$  axis of the graph we locate the point 2000 and read across until we meet the sloping line numbered 34. From the point of intersection we drop a perpendicular to the  $x$  axis and read off the value of  $\rho$ . In the example  $\rho = 0.73$ .

## THE PRODUCT MOMENT COEFFICIENT OF CORRELATION

This gives the exact value of  $r$ , and is calculated in the manner shown in Table 13.



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## TABLE 13

*The Calculation of the Product Moment Coefficient of Correlation*

Pupil.	English Marks.	Arithmetic Marks.	$x$ .	$y$ .	$xy$ .	$x^2$ .	$y^2$ .
A	70	68	+ 21	+ 23	+ 483	441	529
B	74	64	+ 25	+ 19	+ 475	625	361
C	36	32	- 13	- 13	+ 169	169	169
D	56	47	+ 7	+ 2	+ 14	49	4
E	25	21	- 24	- 24	+ 576	576	576
F	92	87	+ 43	+ 42	+ 1806	1849	1764
G	70	52	+ 21	+ 7	+ 147	441	49
H	46	40	- 3	- 5	+ 15	9	25
I	20	9	- 29	- 36	+ 1044	841	1296
J	11	12	- 38	- 33	+ 1254	1444	1089
K	38	40	- 11	- 5	+ 55	121	25
L	52	50	+ 3	+ 5	+ 15	9	25
M	49	54	0	+ 9	+ 0	0	81
N	48	50	- 1	+ 5	- 5	1	25
14 Pupils	Mean 49.07	Mean 44.71			$\Sigma xy$ 6053 5 - 6048	$\Sigma x^2 =$ 6575	$\Sigma y^2 =$ 6018

The column  $x$  shows the differences between the mark obtained in English by the pupil and the mean mark in English; similarly, column  $y$  shows the difference between the actual mark and the mean mark in arithmetic. It will simplify calculations if the whole number nearest to the mean is taken, and the decimal fractions are neglected. The next column,  $xy$ , shows the product of these two differences. Great care should be taken in these columns that the signs are accurate. Columns  $x^2$  and  $y^2$  are self-explanatory. The sums of the numbers in columns  $xy$ ,  $x^2$ , and  $y^2$  are found. Then  $r$  is calculated from the formula

$$r = \frac{\Sigma(xy)}{\sqrt{\Sigma(x^2)(y^2)}}$$

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$$\text{In our example } r = \frac{6048}{\sqrt{6575 \times 6018}}$$

$$\log r = \log 6048 - \frac{1}{2}(\log 6575 + \log 6018)$$

$$\log r = 3.7816 - \frac{1}{2}(3.8179 + 3.7795)$$

$$\log r = 3.7816 - 3.7987$$

$$\log r = \bar{1}.9829$$

$$r = 0.9615$$

If we wish to find the correct value, we must correct the calculation for the decimal fractions which were omitted when finding the differences between the actual marks and the mean mark. This can be done by using the formula

$$r = \frac{\Sigma xy - N e_1 e_2}{\sqrt{(\Sigma x^2 - N e_1^2)(\Sigma y^2 - N e_2^2)}}$$

where  $e_1$  and  $e_2$  represent the differences between the actual means and the assumed means in the distributions.<sup>1</sup>

In most cases this decimal correction makes no appreciable difference. But it may be important, if the mean is small.

If the standard deviations of the distributions have been calculated, the coefficient may be found from the formula

$$r = \frac{\Sigma xy}{N \sigma_x \sigma_y}$$

### PROBABLE ERRORS

These fractions do not mean that there is any error in the value of  $r$ . They merely indicate the extent of the variation of  $r$  on account of sampling chances, especially where the number of pupils is small. If  $r$  is  $+0.32$

<sup>1</sup> This formula is useful when we calculate the coefficient by the shortened method. In this method, we assume the mean to be a whole number, such as 100, and from this we find the differences noted in the  $x$  and  $y$  columns. From the algebraic sum of the  $x$ 's, we can find the true mean by dividing the total by the number of cases,  $n$ , and by adding the answer algebraically to the assumed mean.  $e_1$  and  $e_2$  then represent the differences between the true mean and the assumed mean of the respective columns.

## EDUCATIONAL DEVELOPMENT OF CHILDREN

and the probable error (P.E.) is  $\pm 0.13$ , then it is possible that, if we took different samples and found the correlation coefficient, one might give  $r = 0.32 + 0.13 = 0.45$  and the other  $r = 0.32 - 0.13 = 0.19$ . Such a wide range of possible values of  $r$  indicates that our original coefficient  $r = 0.32$  is not very reliable. For a correlation coefficient to be significant it must be at least three times as large as its probable error when the number of cases is large, but, if the number of cases is small, then any correlation coefficient which is less than four-and-a-half times its probable error should be neglected.

The probable error should always be written after a correlation coefficient with a  $\pm$  sign, to indicate the likely variation and the significance of  $r$ : thus  $r = 0.73 \pm 0.06$ .

The probable error of  $r$  is given by the formula

$$P.E._r = 0.6745 \times \frac{1 - r^2}{\sqrt{N}}$$

For 0.6745 it is usually sufficient to use  $2/3$ .

Thus in our example

$$P.E._r = 0.6745 \times \frac{1 - (0.96)^2}{\sqrt{14}}$$

$$P.E._r = 0.6745 \times \frac{1 - 0.9216}{3.742}$$

$$P.E._r = 0.6745 \times \frac{0.0784}{3.742}$$

$$\log P.E._r = \bar{1}.8290 + \bar{2}.8943 = 0.5731$$

$$\log P.E._r = \bar{2}.1502$$

$$P.E._r = \pm 0.014$$

$$\therefore r = 0.96 \pm 0.014$$

The probable error of  $\rho$  (rank order of correlation) is given by the formula

$$P.E._\rho = \frac{0.7063(1 - \rho^2)}{\sqrt{N}}$$

Thus in our example (p. 47)

$$\begin{aligned} \text{P.E}_\rho &= \frac{0.7063(1 - 0.94^2)}{\sqrt{14}} \\ &= \frac{0.7063 \times 0.1164}{3.74} \\ &= \pm 0.022 \end{aligned}$$

$4\frac{1}{2} \times \text{P.E}_\rho = 4.5 \times 0.022 = 0.099$ , which is considerably less than 0.94, the value of  $\rho$ . The coefficient is therefore significant. If  $\rho = 0.5$  and  $\text{P.E}_\rho = \pm 0.14$ , then  $4\frac{1}{2} \times 0.14 = 0.63$ , which is greater than the coefficient of correlation. This coefficient is therefore not significant.

A glance at the formulæ will show that the greater the number of cases ( $N$ ), the smaller is the probable error. For example, if the number of cases is 50 and the probable error is  $\pm 0.03$ , when the number of cases is increased nine times to 450 then the probable error will be reduced to one-third of 0.03, because  $\sqrt{n}$  becomes  $\sqrt{9n} = 3\sqrt{n}$ . The greater the number of cases the more reliable is the sample.

### “GOODNESS OF FIT”

When we have conducted a test we require to know whether the distribution of the scores we have obtained deviates from the normal distribution and, if it does, whether the deviation is significant. In order to do this we must compare the curve we obtain by plotting the actual distribution of scores with the normal curve which “best fits” the same data—these are the same mean, same  $\sigma$ , and same area (= population). “The essential problem is to compare the obtained distribution with a normal distribution of the same area, and of the same mean and  $\sigma$ , in order to determine whether the differences

## EDUCATIONAL DEVELOPMENT OF CHILDREN

between the two distributions are greater than can be attributed to 'chance'." <sup>1</sup>

The best-fitting normal curve could be drawn by calculating a number of points which lie on it from the formula given on p. 34, plotting them, and joining them together. But the use of the formula involves difficult calculations. A simpler method is to calculate the frequency we should expect in each space-interval if the distribution were normal. This can be done by means of the graph in Fig. 9, which shows, expressed in terms of  $\sigma$ , the proportion of marks which in a normal curve will be above a given mark.

Let us suppose that we have distributed the marks of 100 children and found the frequencies shown in Table 14. We find the mean to be 48 and  $\sigma$  to be 20.

TABLE 14  
*Distribution of Marks in an Algebra Examination*

Marks	f	Marks	f	
90-100	1	40-49	27	Mean = 48 $\sigma$ = 20
80-89	3	30-39	14	
70-79	7	20-29	7	
60-69	12	10-19	3	
50-59	24	0-9	2	

We need to calculate the normal curve with the same mean, 48, and the same  $\sigma$ , 20. We take the lower limit, 90, of the first space-interval, 90-100, and find that it differs from the mean by 42: expressed in terms of  $\sigma$  for the distribution this is  $\frac{42}{20}\sigma$ —i.e.  $2.1\sigma$ . Using the graph,

we find that at  $2.1\sigma$  we should expect the proportionate frequency of 0.02 to be above this point on the distribution.<sup>2</sup>

<sup>1</sup> Garrett, H. E., "Statistics in Psychology and Education," p. 119

<sup>2</sup> Proportionate frequencies are represented as decimal fractions. They may be turned into percentages by multiplying by 100,—that is, by moving the decimal point two places to the right.

# ELEMENTARY STATISTICS

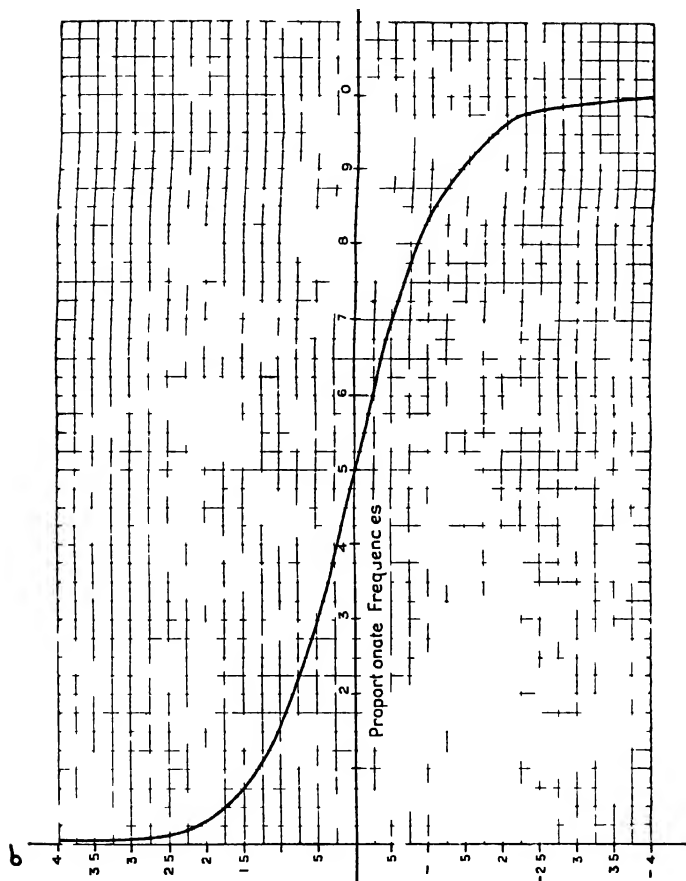


FIG 9—SHOWING PROPORTION OF MARKS IN A NORMAL CURVE WHICH WILL LIE ABOVE ANY GIVEN MARK IN TERMS OF  $\sigma$

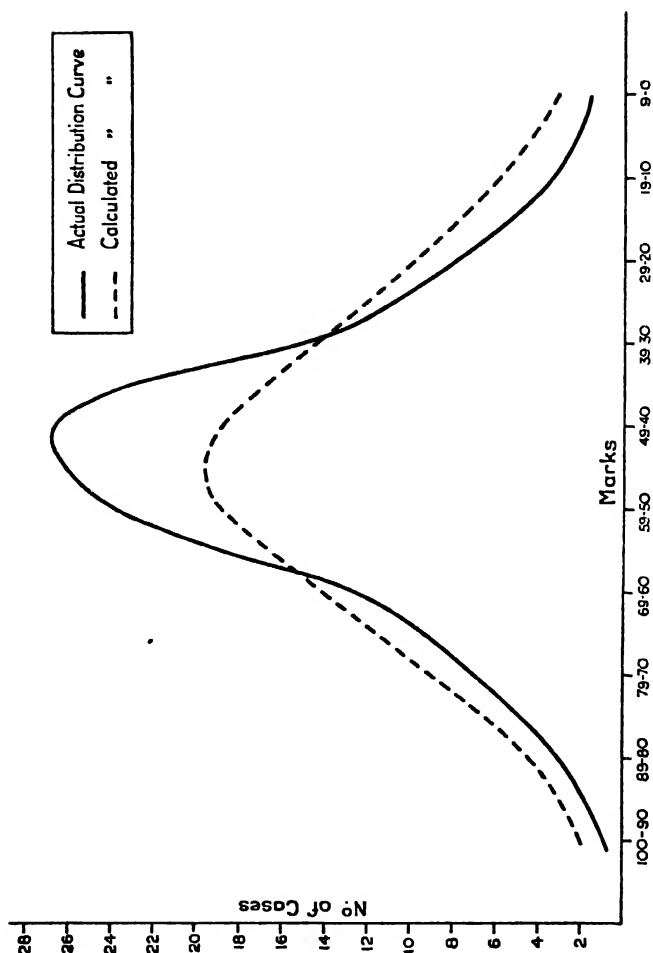


FIG. 10.—THE COMPARISON OF AN ACTUAL DISTRIBUTION WITH THE THEORETICAL DISTRIBUTION BASED ON THE SAME DATA.

# ELEMENTARY STATISTICS

That is we can expect 2.0 per cent of the cases to be above 90 marks. Similarly we find that the lower limit of the next step-interval, 80, is different from the mean by 32 marks or, in terms of  $\sigma$ ,  $\frac{32}{20}\sigma = 1.6\sigma$ . The graph shows that the proportion above 80 is 0.065, or 6.5 per cent of the whole population. So in the class interval 80-89 we can expect to find  $5.2 - 1.8 = 3.4$  per cent of the population. In the same way we can calculate the frequencies for each space-interval. These are shown in Table 15. It should be noted that in the column "frequency expected" the percentages have been calculated to the nearest whole number. For the sake of simplicity, we have taken a distribution in which  $N = 100$ , so that the frequency in each space interval represents a percentage of the distribution. If  $N$  had been any other number than 100, we should have multiplied the expected proportion by  $N$  to make the population of the two distributions the same. For example, if  $N = 250$ , then the expected frequency in the interval 90-100 would be  $0.018 \times 250 = 4.5$ .

TABLE 15  
*Actual and Calculated Frequencies Compared*

Marks	Deviation from mean of lowest limit of space interval	Proportion lying beyond lowest mark	Proportion expected in each class	Frequency expected ( $Fe$ )	Frequency found ( $F$ )
90-100	+2.1 $\sigma$	+0.02	0.02	2	1
80-89	+1.6 $\sigma$	+0.065	0.045	5	3
70-79	+1.1 $\sigma$	+0.14	0.075	8	7
60-69	+0.6 $\sigma$	+0.275	0.12	13	12
50-59	+0.1 $\sigma$	+0.46	0.18	19	24
40-49	-0.4 $\sigma$	+0.65	0.19	19	27
30-39	-0.9 $\sigma$	+0.81	0.16	16	14
20-29	-1.4 $\sigma$	+0.91	0.10	10	7
10-19	-1.9 $\sigma$	+0.97	0.06	6	3
0-9	-2.4 $\sigma$	+1.00	0.03	3	2



# EDUCATIONAL DEVELOPMENT OF CHILDREN

By inspection of the last two columns in Table 15 it appears that, although the obtained curve approximates to the normal, there is some bunching at the centre of the distribution. The differences between the two distributions become more easily noticed if they are plotted on the same axis (see Fig. 10). By drawing the curves we can see at once whether the actual distribution is asymmetrical due to skewness or kurtosis,<sup>1</sup> but we cannot say with accuracy whether these deviations from the normal are significant of real disagreement—that is that they are not due to “chance”, but to some causative factor. Fortunately we can calculate the “goodness of fit” by using Pearson's Chi-Square ( $\chi^2$ ) Test. The formula is

$$\chi^2 = \Sigma \left( \frac{(F - F_e)^2}{F_e} \right)$$

where  $F$  = actual frequencies of series, and  $F_e$  = expected frequencies if the distribution had been normal.

Table 16 shows the calculation of  $\chi^2$  for the distribution we have used in our example.

TABLE 16  
*To calculate  $\chi^2$*

$F.$	$F_e$	$F - F_e$	$(F - F_e)^2$	$\frac{(F - F_e)^2}{F_e}$
1	2	- 1	1	0.5000
3	5	- 2	4	0.8000
7	8	- 1	1	0.125
12	13	- 1	1	0.0769
24	19	+ 5	25	1.3158
27	19	+ 8	64	3.3684
14	16	- 2	4	0.2500
7	10	- 3	9	0.9000
3	6	- 3	9	1.5000
2	3	- 1	1	0.3333
$N = 100$		$\chi^2 = 9.0569$		

<sup>1</sup> For skewness see p. 29. A leptokurtic curve is peaked; a platykurtic is flattened; the normal curve is said to be mesokurtic.

# ELEMENTARY STATISTICS

We can now find the probability ( $P$ ) that the discrepancies between the actual and obtained frequencies are due to fluctuations arising from random sampling by means of tables which statisticians have drawn up for the purpose <sup>1</sup> Table 17 is a shortened form of the larger tables It will cover most distributions encountered by teachers

TABLE 17

*To Calculate  $P$  for Goodness of Fit if  $\chi^2$  is known*

$n$  Number of space intervals

$\chi^2$	$n = 7$	$n = 8$	$n = 9$	$n = 10$	$n = 11$
1	0.99	0.99	1.00	1.00	1.00
2	0.92	0.96	0.98	0.99	1.00
3	0.85	0.88	0.93	0.96	0.98
4	0.68	0.78	0.86	0.91	0.95
5	0.54	0.66	0.76	0.83	0.89
6	0.42	0.51	0.61	0.74	0.81
7	0.31	0.41	0.54	0.64	0.72
8	0.24	0.33	0.43	0.53	0.63
9	0.17	0.25	0.34	0.44	0.53
10	0.12	0.19	0.26	0.35	0.44
11	0.09	0.14	0.20	0.28	0.36
12	0.06	0.10	0.15	0.21	0.28
13	0.04	0.07	0.11	0.16	0.22
14	0.03	0.05	0.08	0.12	0.17
15	0.02	0.04	0.06	0.09	0.13

In our example  $\chi^2 = 9$  to the nearest whole number, and the number of space intervals is taken as 8—the “small frequencies at the two extremes of the distribution have been combined, since the  $\chi^2$  test is more valid when no theoretical  $F$  is less than 5” <sup>2</sup> From Table 17 we learn that  $P$  in this example is 0.25 This indicates that

<sup>1</sup> See Pearson, K. Tables for Statisticians and Biometricians 1914 pp 26-28, and Garrett H. F. Statistics in Psychology and Education pp 124 and 379

<sup>2</sup> Garrett H. F., Statistics in Psychology and Education " p 123 footnote

## EDUCATIONAL DEVELOPMENT OF CHILDREN

there are twenty-five chances in 100 that the differences between the frequencies of the normal and the actual distributions could have arisen by chance. This indicates that we have sufficient "fit", because for the differences to be significant,  $P$  should be below 0.02.

Should  $P$  indicate that the deviations are not due to chance, the cause of the differences should be sought. It may be that the size of the group is too small, or that the children tested have been selected—for example, the  $A$  stream in a grammar school or a class in a school for dull and backward children—and therefore are not a "random sample". Faults in the marking of the test or in its construction are frequently causes. Moreover, we must remember that often the data are not normally distributed: if we set the top class in a secondary school to do the simple arithmetic of the junior school, we should expect the distribution to be negatively skewed, for all would get high marks. Standard tests, however, are constructed so that if the population of testees is large enough the scores will be distributed in a way which does not differ significantly from normality.

### CHAPTER III

## PHYSICAL QUALITIES

#### DISEASES AND DEFECTS TO BE NOTED

EVERY school-child is examined periodically by the School Medical Officer, and the results, entered on the medical record card, are made available to the headteacher. Most of the information does not concern the class teacher, but there are some observations which it is essential that he should know. These observations should be abstracted by the headteacher, entered on the record card, and supplemented by information on the physical health of the children which the teacher has gleaned for himself. With the help of this knowledge, the teacher will be prepared to meet the symptoms of any disease from which one of his children may be suffering and will be ready to take appropriate action. If he knows a child is epileptic, for instance, he can have a cork or other gag to hand, and he can arrange for the child to sit in a suitable place.

If a child has suffered from a disease which is liable to develop certain symptoms requiring immediate treatment or against which precautions can reasonably be expected to be taken in school, the nature of the illness should be entered on his record card. Pneumonia, bronchitis, middle-ear trouble, mastoid, rheumatism, rheumatic fever, recent diphtheria, recent scarlet fever, and heart trouble may recur or lead to unfortunate after-effects unless care is taken. Those who have suffered from pneumonia and bronchitis should avoid a damp, stuffy atmosphere and a rapid change of temperature, such as that produced by sitting near to a fire and then moving into the cold air; and children who have ear trouble should take special

## EDUCATIONAL DEVELOPMENT OF CHILDREN

precautions when bathing or when playing "rugger". In cases of rheumatism and rheumatic fever, damp and heart-strain are the enemies. As is well known, the child suffering from heart trouble must avoid violent exercise and over-excitement.

There is no need to enter on the card details of many of the common infectious illnesses, except as explanations of absence. Nevertheless every teacher should know the symptoms of the most common diseases and functional disorders so that he can "spot" cases in their early stages and take suitable precautions. Measles, German measles, scarlet fever, whooping-cough, chicken-pox, mumps, scabies, impetigo, ringworm, conjunctivitis, are among the most frequently occurring. The teacher should watch carefully and refer to the doctor any child who is pale, listless, and lethargic, for these signs are often symptoms of malnutrition with accompanying gastro-intestinal troubles or tuberculosis.

Among the diseases which should be recorded because symptoms may develop in school that need attention are hæmophilia, diabetes, asthma, chorea, and habit spasms.

Hæmophilia, found only in males, is a hereditary disease which is characterized by prolonged bleeding—it may go on for days—from even the slightest wounds, such as superficial abrasions. Boys suffering from this complaint must be helped to avoid risks and need instant medical attention for the slightest scratch.

Children suffering from diabetes may live a normal life, provided that they have doses of insulin regularly and live on a carefully regulated diet. But sometimes the balance of insulin and sugar is upset by a sudden outburst of violent exercise, by failure to eat sufficient food, or by the omission of a dose of insulin. If the child lacks sugar he will become pale, and quiet or fretful in mood. This state will be followed by drowsiness, lack of co-ordination

## PHYSICAL QUALITIES

of movement, and finally coma. A fit may occur at the onset. The teacher should keep some lumps of sugar ready for such an emergency. But the child may also go into a coma because of a lack of insulin. Usually the child will be able to tell whether it is sugar or insulin that is required. But if there is any doubt at all the doctor must be summoned.

Another common complaint, especially in boys, is asthma which is sometimes associated with hay-fever. Any dusty atmosphere is likely to precipitate an attack, and violent exercise is likely to cause discomfort. Therefore, children suffering from this disease should be protected at all times from dust, and the teacher of physical training should see that they do not become unduly breathless in the gymnasium or at games.

Chorea (St. Vitus' Dance) usually occurs between the ages of five and twelve, and is often associated with rheumatic heart. The cause of the disease is obscure, but there seems little doubt that worry and overwork at studies are contributory factors. Some words on chorea by Dr. W. Sheldon<sup>1</sup> should be noted by all teachers. "Chorea is much more common among the children of the poorer classes than among those of the well-to-do. Children who are alert and intelligent, learning quickly at school, are much more likely to be affected than those who are dull and placid, indeed the important part played in the production of chorea by the stress of education, and especially by the anxiety of examinations and scholarships, cannot be doubted." This is all the more important because, although grave cases are infrequent, mild cases are common and are often overlooked. The teacher should treat children suffering from a mild attack as educationally normal, but should make sure that strain is avoided, especially in games and P.T. Chorea may be

<sup>1</sup> " Diseases of Infancy and Childhood," p. 548.

## EDUCATIONAL DEVELOPMENT OF CHILDREN

preceded by an illness of so mild a nature that medical advice is not sought. Some time after the illness, involuntary movements occur in some part of the child's body. These movements become more frequent and spread to all parts of the body. The child drops things, makes faces, and is unable to concentrate. If, consequently, he is punished for bad behaviour, an emotional disturbance will probably occur. This will make his involuntary movements even more pronounced, so that he may eventually be able to dress and undress only with great difficulty, and may alternate rapidly between meaningless laughter and crying. Complete rest of body and mind usually brings about a full recovery, but the child should be carefully watched on his return to school as relapses are frequent. He should not be pressed in his academic work, and he should be required to perform only very gentle exercises in Physical Training.

Habit spasms (tics), such as abnormal blinking of the eyes, twisting of the mouth to one side, shrugging the shoulders, or tossing the head, are often mistaken for symptoms of chorea. But in habit spasms the movement will be repeated involuntarily and frequently for a few days or weeks, and then may be replaced by another. They usually occur in highly strung, nervous children, of five to seven years of age. They have nothing to do with chorea, and do not of themselves interfere with general health, although they may do so indirectly. There is no one cause of such spasms, although they are always associated with mental strain. Children so affected should be referred to the school medical officer, who will probably allow them to attend school, for, if left at home with little to do, they may become worse. There is no fear of the habit being "caught" by other children. The teacher should not draw the child's attention to it, nor make any attempt to break the habit.

## PHYSICAL QUALITIES

Aches and pains in the limbs—the so-called “growing pains”—are a common complaint in childhood, especially between the ages of six and ten. There is no evidence to show that they have any relation to more serious forms of rheumatism.<sup>1</sup> In general they are either associated with a moist atmosphere or with fatigue at the end of the day. This complaint affords another reason for keeping classrooms adequately warm and well-aired and for seeing that children have sufficient rest.

## GENERAL VITALITY

The general vitality of a child is often a good guide to his physical condition. Lack of vitality may be due to weakly or unhealthy parents or to bad environmental conditions, such as lack of fresh air and sunlight, insufficient sleep, and inadequate or unbalanced feeding. Not only is a child of low vitality likely to catch infectious diseases because of his low powers of resistance, but also his poor condition results in the metabolism of the body being upset, and this prevents the building up of the tissues.

When the vitality is low sore throats are frequent; and sore throats in turn lower the vitality of the child. The throat, it must be remembered, is one mode of entry into the blood-stream of harmful organisms. In order to avoid sore throats, the teacher should see that, at all times, the children do not sit in wet clothing or with wet feet, and that they are not subjected to chills. Chills are especially liable to occur when children, after running about in the playground, wait in lines before they enter school, when they queue in the open without adequate protection in order to enter the dining-hall, and when, after a strenuous Physical Training or Games lesson, they

<sup>1</sup> See W. Sheldon: “Diseases of Infancy and Childhood,” 1946, p. 611.



## EDUCATIONAL DEVELOPMENT OF CHILDREN

do not put on adequate clothing. The child when hot will tend to take off his clothing; the teacher should show him the wisdom of putting on clothing so that he can "cool down" gradually. Should a child be suffering from a sore throat he should be kept in a constant temperature; for this reason it may be better, provided that it is not infectious, for the child to be at school rather than at home or in the street. Recurrent sore throats give rise to catarrhal troubles, and these in turn produce eye-trouble, headaches, and even bouts of fever. In class the child will be restless and inattentive. Medical attention is required in order to increase the vitality of the child so that he can resist infection.

Dental trouble may be a cause of the lowering of vitality, but in childhood it seems to have little effect, its main influence being felt in early adult life. Nevertheless the teacher should encourage the children to make full use of the school dental services and to take care of their teeth.

There is a danger that an infection of the mouth or skin may be passed from one child to others as a result of his having meals at school. The utensils used by a child known to have a sore mouth or a rash on his hands should be sterilized immediately after the meal.

In all cases of lowered general vitality the teacher must remember that there are no quick remedies. The removal of the tonsils, for instance, may even for a time give an educational set-back. The child of low vitality should be receiving medical attention. The teacher should see that the school co-operates to its fullest power in helping him.

## POSTURE

Bad postures and ungainly deportment may be bad habits or symptoms of disease. For example, spinal curvature may be due to loss of the postural reflex or to

## PHYSICAL QUALITIES

tuberculosis of the spine. If the defect arises from disease, then the teacher can do little about it and must rely on the medical officer; but the postural reflex can be restored by practice in sitting-up and other remedial exercises. The doctor will prescribe when remedial treatment is required for defects, such as flat feet and minor cases of knock-knees and bowlegs, and his opinion will be recorded for the benefit of the physical education teacher. When bad carriage is the result of poor neuro-muscular co-ordination much may be done to improve it in the physical training lessons.

## PHYSICAL DEVELOPMENT

When we consider the physical growth of the child it is essential to remember that development proceeds not uniformly but at different rates at different periods of a child's life. Nor are mental and physical progress made at the same rate. One child may be making great advances mentally, while physically he is for the time being arrested, while another may develop equally well in body and mind during the same period of time. Height, of all bodily measurements, is probably the best indication over a long period of general physical development; weight is the most useful indication over a short period. Abnormal changes in both measurements may be indications of ill-health. In height there is a slight difference between the sexes. Thus a retardation in the rate of growth of girls occurs at about 9 years of age, whereas with boys it may be two years later. Girls grow rapidly from the age of about thirteen years, whereas boys are nearly 15 before they reach this stage. Such deviations can cause a good deal of trouble in the seating of mixed classes. The height of the desks should be considered carefully at all times.

## EDUCATIONAL DEVELOPMENT OF CHILDREN

The measurements of height and weight are distributed normally, so we must not worry unduly if a measurement seems too great or too small. We should bear in mind tables of average heights and weights, but remember that they may mislead us, since these measurements have no absolute values, except in so far as a boy who is small may have a feeling of inferiority which he compensates by a superior attitude. What matters is "the curve of growth", and for this reason it is better to record the measurements graphically and to make sure that they are taken at evenly spaced intervals of six months. When a child shows undue growth or little increase in height, and when his weight shows a rapid change up or down, these facts should be noted, and, although many of these seemingly abnormal variations may have no clinical significance, they should be referred to the doctor for his interpretation. Rapid growth in a child, for example, nearly always means a rapid fatigue rate. It is therefore of doubtful value to a quickly growing child to urge him to certain physical efforts, and in some instances periods of rest would be of more value than violent physical exercise.

For the purposes of recording, some squared paper should be provided in the record card. The  $x$ -axis will represent the age, with each square representing a month, and the  $y$ -axis will represent both height in inches and the weight in pounds. Height should be entered in red, weight in blue. Fig. 11 shows the graph of the average growth of height and weight between 4 and 16 years.

## DEFECTS OF SENSATION

Sense defects, especially those of sight and hearing, are liable to handicap a child both in his studies at school and afterwards in employment. The teacher should be prepared to notice any symptoms, such as the "screwing up" of the eyes or inability to hear clearly, and, where deficiency

## PHYSICAL QUALITIES

is suspected, to see that the child is specially examined. The information which will appear on the school record will be obtained from the medical officer.

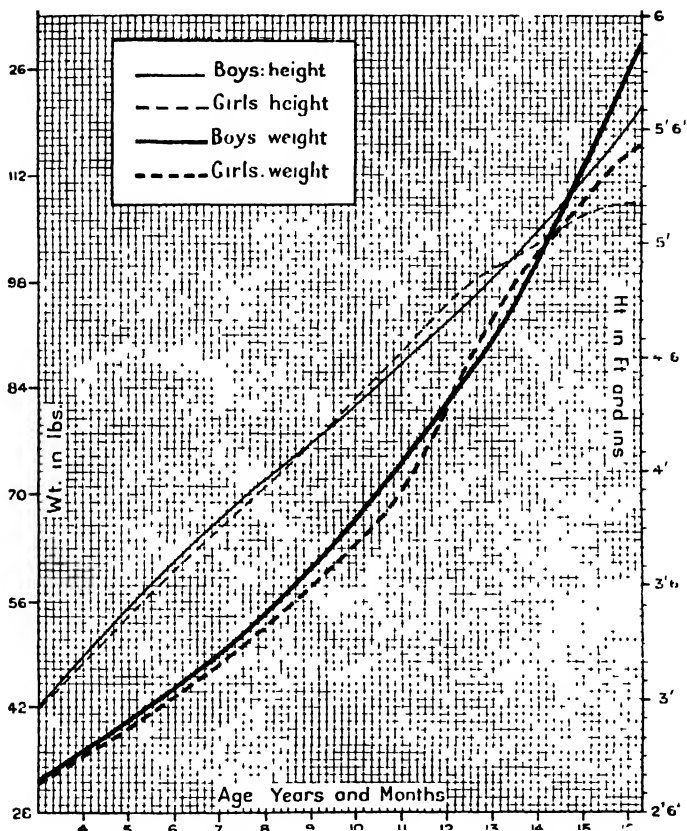


FIG. 11.—AVERAGE GROWTH RATE OF A CHILD

As far as vision is concerned, the figures of the oculist are of little concern to teachers. They want to know if a child is short-sighted or long-sighted, so that he can be placed in the most suitable position in the class. The

## EDUCATIONAL DEVELOPMENT OF CHILDREN

short-sighted (myopic) child can usually be detected because he holds his books too near his eyes. Hypermetropia (long-sight) and astigmatism are far more likely to be missed than myopia. Hypermetropia is very prevalent between the ages of five and seven. By an effort the child can focus on his work, and consequently the condition is often overlooked, even at medical inspection. The teacher, who has more opportunities of observing the child, may here render valuable assistance, for he may notice in the child the feeling of strain which produces aching eyes, headaches, and a general vague discomfort. As we have seen, blinking of the eyes as a habit has no relation to eyesight difficulties.

Defects of hearing are often missed by routine inspection unless the children are specially tested. A child who is slightly deaf may not hear sounds clearly, but can hear sufficiently well to grasp the general sense of a sentence. It may be, because of this slight deafness, a child does not make normal progress in class and is regarded as mentally backward by the teacher. Just as some people are colour blind and cannot distinguish one colour from another, so others suffer from high-frequency deafness and cannot distinguish high notes. Children who are thus afflicted are unable to distinguish sounds such as "ee" from "oo", or "s" from "f" or "th". Obviously such children may become educationally retarded because of their difficulty in following speech.

Defective articulation and lisping can usually be cured by training, but stammering is almost always a symptom of a neurotic condition. Teachers can do much to overcome minor speech defects, but in the more important cases, such as stammering, a speech therapist should be consulted.

## PHYSICAL QUALITIES

### EFFECT UPON EDUCATIONAL STANDARD

Absences from school should be noted by showing the number of actual attendances as a fraction of the possible attendances. At the same time any long absences due to illness should be recorded, so that they are not overlooked when a child's work and progress are assessed. Recent illness may for a time have a marked effect upon the standard of work achieved, but in general a child quickly recovers mentally and physically from most illnesses. So long as the teaching is adjusted to give constant revision, the influence of an absence upon the mental growth of a child may be ignored after a few months. But if a child is away frequently, especially in the early years of school life, he will tend to be educationally retarded. Nevertheless the teacher should encourage the child to forget his absences. Parents are often too inclined to blame bouts of illness as the primary cause of a child's backwardness, when in reality it is due to incapacity.

Sometimes, however, a child, especially if he is naturally backward, may find himself so far behind the average attainment of his age-group that it is necessary to place him in another class. In this event he will need special care, for, if he is placed in a class of his own chronological age, he will be in great difficulty, and, if put in a class of his own attainment level, his emotional development may be adversely affected, because he is so much older than the other children and so much bigger physically. It is better if such children are withdrawn and put into small groups for tuition until they have caught up in their attainments, when they should be returned to ordinary school life. Except for such tuition, no special notice should be taken of backwardness due to illness, and the sooner the child is returned to the normal stream the better. The teacher should see that the child has an opportunity of

## EDUCATIONAL DEVELOPMENT OF CHILDREN

learning the work he has missed, and above all should avoid making the child anxious about his progress.

The incidence of illness to some extent varies with the social class to which the children belong, for, as we have already noted, environment plays a part in general physical well-being. Partly because they have less power to adjust themselves to their environment, dull and backward children seem more prone to illness than normal children, but, since in recent years intensive study and particular attention have been given to these children, the difference between them and normal children in this matter is not great. Sir Cyril Burt in "The Sub-Normal Mind" <sup>1</sup> gives the following figures:—

School attainment :	normal	38%	suffer from physical defects.
"	"	dull and backward	45% suffer from physical defects.
"	"	defective children	52% suffer from physical defects.

From these figures Burt concluded that their greater liability to illness and bodily weakness is only an accessory factor in their mental backwardness and not the cause of it. He suggests that ill-health may retard such a child's ultimate development by the equivalent of 6 to 12 months' progress, but no more.

There is a tendency for children suffering from adenoids to appear dull and backward. The latest medical opinion suggests that adenoids do not of themselves retard children; but in so far as they cause partial deafness, lowering of vitality, and loss of the power to concentrate, they may, indirectly, seriously impede a child's progress. Perhaps this is a fitting place at which to note that mouth breathing may be due to adenoids or to habit; in the latter case the teacher should help to cure it, for mouth breathing can lead to frequent sore throats and we have seen what complications may ensue from that condition.

<sup>1</sup> 2nd Edition, p. 128.

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### ✓ THE TEACHER'S PART

“ Teachers are sometimes apt to consider that their duties relate mainly to the mental development of their pupils, and that physical care is a separate domain, which is the province of the parent and of the School Medical Service. This attitude is unfortunate, for it should be widely recognised that, as progress in school is conditioned almost as much by physical factors as by mental ones, provision for physical growth should rank equally in the teacher's work with management of mental growth.” <sup>1</sup>

The teacher can do much in co-operation with the medical services to promote the health of the school child, but his first concern is with the influence of the physical development of the child upon his educational progress. For this he should have certain essential information, and we suggest that this should be recorded in as full a manner as possible.

✓ The good teacher will not only record the physical qualities of his charges, he will also

1. master thoroughly the elements of hygiene and put them into practice ;
2. teach the children the general principles of healthy living and encourage them to practise them the science, domestic science, and physical education teachers should all co-operate for this purpose ;
3. encourage, through parents' associations and similar means, better home environments and the active co-operation of the parents in providing healthy living conditions for the child ;
4. follow scrupulously the recommendations of the medical officers and the school dentists and encourage the children to do so ;
5. report any suspicious deviations from the normal to

<sup>1</sup> F. J. Schonell : “ Backwardness in the Basic Subjects,” p. 40.



## EDUCATIONAL DEVELOPMENT OF CHILDREN

the headteacher for transmission to the medical officer ;

6. with the physically weaker children, try to avoid frustrations, mental conflicts, and feelings of inferiority.

No attempt has been made in this chapter to consider the performances of children in physical training and games. These activities are to some extent governed by the physical condition of the children, but it would be wrong to assume that, because a boy is a member of the school team, he is in the highest class physically. It seems that success in physical activities depends upon a number of factors ; neuro-muscular co-ordination, special interest, general factors such as " ball sense ", and specific factors such as those which distinguish the sprinter from the long-distance runner. It is true that a number of games depend upon a " good eye " and soundness of lungs and heart, but, generally speaking, they depend for success as much on practice and special abilities as upon good physique. It seems better, therefore, that we should consider them (for the purposes of the record) as attainments.

## CHAPTER IV

### GENERAL MENTAL ABILITY

#### " INTELLIGENCE TESTS "

TESTS of general mental ability (" Intelligence Tests ") are widely used for school purposes, and it is probable that in the future they will become even more important. It is essential, therefore, that we should understand their significance and how to apply them.

Let us first make sure that we know what we understand by the term " Intelligence Tests ". The name is scientifically a misnomer because, apart from the fact that the term intelligence has different meanings for different people, it suggests that the tests measure an entity which we possess in the same way that we possess eyes, and hands, and ears, whereas intelligence is a characteristic of behaviour—that is, we behave with a certain degree of intelligence. But, as Professor Spearman points out,<sup>1</sup> this behaviour may depend upon two entities : a general mental " energy " common to mental processes of all kinds and " a specific mental ' engine ' peculiar to this process ". The metaphor of the engine and energy is not completely appropriate, but the general trend of research in this country has confirmed the opinion that our behaviour is largely governed by a general capacity—often referred to as " *g* "—roughly identifiable with what Galton called innate ability and Binet called intelligence—a capacity depending to a large extent on reasoning and ability to grasp complex ideas—working in conjunction with a number of more specialized aptitudes (sometimes called group factors), such as memory, and the various verbal, arithmetical, musical, artistic,

<sup>1</sup> " A Measure of ' Intelligence ' " and " The Nature of Intelligence "

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manual, mechanical, spatial abilities.<sup>1</sup> All so-called "intelligence" tests aim at measuring this general mental ability by submitting the children to experiences from which the group and specific factors have been eliminated. It would be better, therefore, to call them tests of general mental ability. The importance of this characteristic for the understanding of any child is obvious.

A brief account of the development of these tests will help us to understand more clearly their nature and use. Since the Industrial Revolution, success and failure have become more pronounced and a premium has been set on the ability to deal intelligently with the complicated environment not only by the outstanding achievement of the brightest, but also by the sufferings of the "slow-minded". At the beginning of the nineteenth century it was realized that the feeble-minded were a liability to society. It was thought that by training they could be made fit to play their parts in industry; for at that time there seemed to be no reason why it should not be possible by suitable methods of education to bring them up to the level of normal people. As we can now understand, these hopes were never realized, for all the evidence seems to indicate that "intelligence" cannot be increased, and that it is distributed according to the normal laws of chance, and to the known laws of heredity—that is, its distribution follows the normal curve and, in general, unintelligent stock will give birth to unintelligent children and vice versa.<sup>2</sup>

<sup>1</sup> This two-factor theory of Spearman has been modified in the light of recent researches. We have given a very brief explanation of modern views in pp. 129-132. For the purpose of this chapter, it is sufficient to note that tests chosen to measure the general factor, "intelligence", may at the same time measure other factors, such as the group factor, verbal facility (denoted by "*gv*"), in all verbal tests, and the group factor, spatial relations ("*gK*"), in tests involving figures, diagrams, and pictures.

<sup>2</sup> It should be noted that there is a tendency to regress towards the mean as in other distributions of human traits.

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After some attempts at educating the less able people, teachers and psychologists found that it was not only a question of the sound in mind and the feeble in mind; they realized that men and women possessed ability in varying degrees. This was brought home at the beginning of this century, when the Ministry of Public Instruction in France, disturbed at the large numbers of children who were so backward in their school work that they appeared to be feeble-minded, instituted an inquiry. Binet, a psychologist, and Simon, a psychiatrist, collaborated and published their findings in a paper entitled "The Development of the Intelligence of Children."<sup>1</sup> The lines along which their minds were moving can be observed in their statement of their objects in "*Les idées modernes sur les enfants*" (1909):

"To invent a large number of tests, at once rapid and precise, and presenting progressive difficulty: to try these tests on a large number of children of different ages: to note the results; to see which tests succeeded for a given age, but cannot be done as a rule by children even a year younger; to construct in this manner a metric scale of intelligence, which permits of determining whether any given subject has a normal intelligence for his age, or is backward, or forward, and how many months or years this backwardness or forwardness amounts to."

The tests were so planned that they could be scored as "passed" or "failed", and the total of successes gave the child's "mental age". It is interesting to note that the tests were tried out on a large number of children, and those tests were selected which usually "succeeded for a given age". This means that Binet and Simon were assuming that general mental ability was normally distributed. This assumption is made in the building of all "intelligence scales", and must be remembered when we are

<sup>1</sup> *Année Psychologique*, 11, 1905.

interpreting the results of the application of any such test.

Since Binet's death in 1911 careful experimentation followed by statistical analysis and adjustment has produced more reliable tests. The one most frequently used is the New Stanford Revision of the Binet-Simon scale published by Terman and Merrill in 1937. This test, with two parallel forms, *L* and *M*, and applicable to all persons over one-and-a-half years of age,<sup>1</sup> has the advantage that it is issued with very full instructions for its application and for scoring. The forms, standardized in America, have been modified to some extent to make them suitable for children born in England and Scotland, and they are being further revised by a committee under Sir Cyril Burt.

Variations of these tests to be applied to individuals or to groups of people have become popular in several spheres of life where selection is necessary; they have become useful tools for establishment and personnel officers, for education authorities selecting children for secondary education, and, as we have seen recently, for the armed forces in assigning men to the different branches.

The popularity of "intelligence" tests in the educational world is easy to understand. At one time selection for secondary education, for example, depended upon an examination in attainment in certain subjects. There were many complaints, especially to the effect that the children most fitted to profit by an extended and better education had not been selected; for attainment depended upon so many variable factors—the quality of the teaching varied from school to school, some children were ill at critical periods of their training, and one child was coached

<sup>1</sup> "Measuring Intelligence," by L. M. Terman and M. A. Merrill, p. 34.

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privately, whilst another was one of forty in a single-teacher all-age school; moreover, the marking of the tests so often depended upon personal bias or whims. It seemed to some teachers and authorities that the test of general ability got rid of all these anomalies, and in consequence they began to set tests of "intelligence". Some education authorities have gone so far as to base their selection on this test alone. But new ideas in education are producing yet another change. The principle has been laid down that children should be educated not only according to ability, but also according to aptitude. In view of this the test of general ability has lost some of its prestige, but it still remains an important criterion in the selection of boys and girls for the different types of education at 11+.

## THE INTELLIGENCE QUOTIENT

In order to indicate the general mental ability of a child, his mental age (M.A.), as discovered by the application of the tests, is compared with his chronological age (C.A.). This fraction is multiplied by 100 to make it easier to handle, and the result is called the intelligence quotient (I.Q.) of the child. Since the normal child would have the same mental age as chronological age, its I.Q. would be 100. This I.Q. is therefore the mean of the distribution.

$$\frac{\text{M.A.}}{\text{C.A.}} \times 100 = \text{I.Q.}$$

In group tests of intelligence it is usual to arrange marking in such a manner that the score of the child may be turned at once into the I.Q. from tables of "norms". These

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measures can quickly be changed into Mental Ages by using the formula in the form.

$$\text{M.A.} = \frac{\text{I.Q.} \times \text{C.A.}}{100}$$

It has been found from many experiments that the I.Q. of any given child does not alter considerably so long as there is no great environmental change. "It is a matter of general agreement" states the Ministry of Education's Pamphlet on "Special Educational Treatment" "that 'intelligence' cannot be substantially improved by any methods known to us at present."<sup>1</sup> Dr. Ramer in his study of Stockholm boys and girls<sup>2</sup> found "those who could be retested in adult life showed no change in their intelligence". It is well known, however, that mental capacity is adversely affected by certain diseases, and that unfavourable circumstances often prevent it from developing to the full. Although it seems that this general ability cannot be increased, an improved environment will enable the child to make better progress; this we can see if we visit any school which caters especially for dull and backward children, for there we shall find boys and girls performing in a way which seemed beyond them in the normal school environment. This does not mean that they become more intelligent, but that what intelligence they have is more fully developed.

Since the I.Q. tends to remain constant, we can, once it has been calculated, forecast a child's mental age from his chronological age by using the formula mentioned earlier. If a child of 9 years of age has an I.Q. of 110 his mental age is  $9 \times \frac{110}{100} = 9.9$  years. At 12 years of age his mental age will be  $12 \times \frac{110}{100} = 13.2$  years. The improvement in

<sup>1</sup> "Special Educational Treatment," p 18

<sup>2</sup> See account in *British Medical Journal*, 15 Nov., 1947

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mental capacity will continue to about the age of 14 or 15 years, although in some cases it may stop earlier and in others go on rising even later. A few exceptional case-histories have shown a slight rise up to 18 or 20 years of age. Most psychologists consider that the significance of the tests is doubtful above the age of 15, and, for purposes of calculating I.Q.'s, an age of more than 15 is reckoned as fifteen. Ability to learn, which is certainly dependent on intelligence, reaches a maximum at from fifteen to twenty years, remains constant until about twenty-five and drops slowly to forty-five years, when the ability is about 10 to 20 per cent less than it was at twenty years of age. Thereafter the rate of decline varies greatly from individual to individual, and no general figures can be given.

As we have seen, the tests are so constructed that I.Q.'s are distributed normally around the mean of 100. Table 18, based on this hypothesis of normal distribution, gives the frequencies with which we can expect to find I.Q.'s distributed in a normal population, and indicates the type of child associated with the different I.Q.'s.<sup>1</sup> The graph,

<sup>1</sup> We should like to emphasize that the S.D. of this table is 16.5. If we calculated the theoretical frequencies using a S.D. of 15, we should find the following distribution.

over 140	.	.	.	0.4%
131 to 140	.	.	.	1.8%
121 to 130	.	.	.	6.8%
111 to 120	.	.	.	16.0%
101 to 110	.	.	.	25.0%
91 to 100	.	.	.	25.0%
81 to 90	.	.	.	16.0%
71 to 80	.	.	.	6.8%
70 and below	.	.	.	2.2%

Where an I.Q. of 70 is taken as the borderline for special educational treatment, the S.D. is assumed to be 15. The S.D. of the modern Stanford-Binet I.Q.'s is now usually taken as 16.5, although formerly it was assumed to be 15. (Vernon, "The Measurement of Abilities", p. 86). Moray House use a S.D. of 15. There is no "correct" standard deviation and for this reason figures given in different text-books are not always comparable.



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## TABLE 18

### *Intelligence and Ability*

Grading	I Q	% Frequency	Cumulative Frequency	Notes
Genius	Over 170	0.001	0.001	100
Very brilliant	161 to 170	0.02	0.021	99.99
Brilliant	151 to 160	0.11	0.13	99.98
Very superior	141 to 150	0.67	0.80	99.87
Superior	131 to 140	2.89	3.69	92.1
Very bright	121 to 130	7.40	11.09	96.10
Bright	111 to 120	16.00	27.09	81.0
Superior average	101 to 110	23.00	50.09	68.0
Inferior average	91 to 100	23.00	73.09	51.00
Dull	81 to 90	16.00	89.09	27.00
Subculturally dull	71 to 80	7.40	96.49	11.00
Borderline M D	65 to 70	1.80	98.29	3.60
M D morons	55 to 64	1.80	99.99	1.80
Imbeciles	25 to 44	0.1	99.99	0.11
Idiots	Under 25	0.01	100	0.11

S.D. 15.5

Fig. 12, shows the same relationships. The table should be studied carefully. We see immediately that over 70 per cent of the total population of children have I.Q's lying between 80 and 120. These children are all capable of benefiting by the type of education given in primary and in secondary modern schools. Children with higher I.Q's would benefit by being educated in a grammar or technical secondary school, whilst those below 80 usually need special attention, though not necessarily in a special school. For those boys and girls with an I.Q. above 75 who are backward in their work a special class using special methods of teaching is beneficial. Those between 55 and 65, and a good many boys and girls with I.Q's between 65 and 75, upon the recommendation of the education officer in consultation with the school medical officer, should go to special schools. The morons or feeble-minded (with I.Q's between 55 and 65) will be able to perform routine tasks, and the best of them can learn to earn their own living. Usually, however, they are quite incapable of using their spare time to advantage, and

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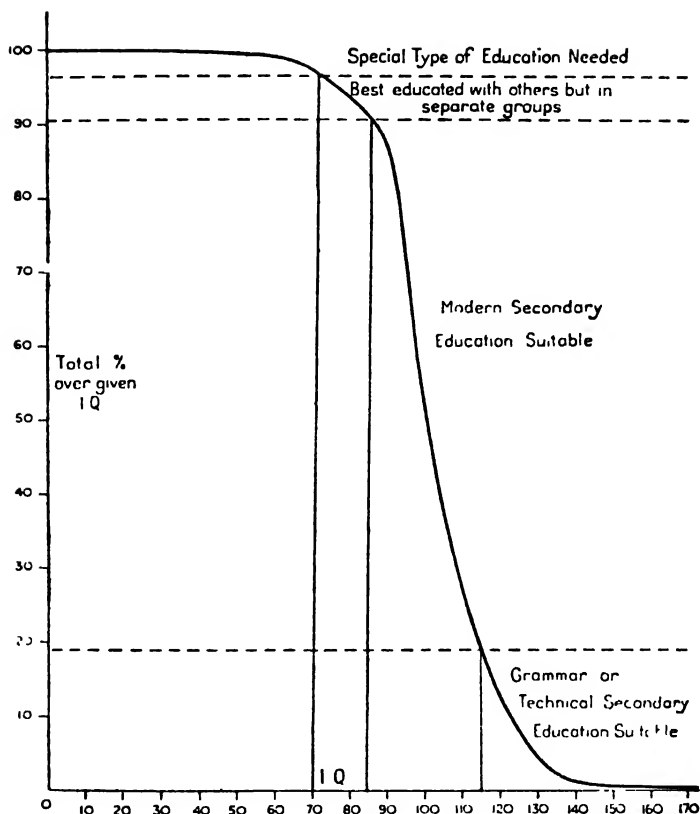


FIG. 12 CUMULATIVE FREQUENCY CURVE FOR "IQ"

are easily led into a life of prostitution or petty theft. They are usually caught owing to their inability to adjust themselves to any novel situation. "Past experience suggests that children cannot be educated at school when their intelligence quotient is below about 55."<sup>1</sup> Imbeciles

<sup>1</sup> Ministry of Education Pamphlet on "Special Educational Treatment," p. 20.

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will avoid the common dangers of life, and under constant supervision can learn to do the simplest tasks. They may be distinguished from idiots, who are legally classified (Mental Deficiency Act, 1927) as those who, by reason of their mental deficiency, are unable to guard themselves against common physical dangers. Most idiots cannot wash or dress themselves, and those with the lowest I.Q's cannot even learn to eat and drink.

Other important facts emerge. Suppose we test 600 children—that is, approximately one year's entry to school in a total population of 50,000. Approximately 15 per cent of these children—that is, ninety—will enter a grammar or technical secondary school. These will form three classes which, if graded according to their I.Q's, will be divided in the following manner :

- Class 1. I.Q's 127 to 170 . . . Range 44
- Class 2. I.Q's 121 to 126 . . . Range 6
- Class 3. I.Q's 117 to 121 . . . Range 5

Approximately thirty-six to forty children will need special education, leaving 470 children to go to the secondary modern schools. These will be distributed probably fairly evenly between five or six schools. Taking the ninety pupils admitted to any one school and grading them according to their I.Q's, we have :

- Class 1. I.Q's 104 to 116 . . . Range 13
- Class 2. I.Q's 90 to 103 . . . Range 14
- Class 3. I.Q's 70 to 89 . . . Range 20

We see at once the greater variation in the top form of the grammar school and in the lowest stream of the modern school. These classes will be the most difficult to teach, as the pupils will develop mentally at varied rates. Thus Class 1 at the grammar school, with a mean chronological

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age of eleven years, will have a mental age range of 14.06 to 18.7 years, and Class 3 at the modern school, with the same mean chronological age, will have mental ages ranging from 7.7 to 9.8 years. Class 3 at the grammar school on the same basis will have mental ages of 12.9 to 13.3 years. This suggests that of the teachers in the grammar school the most efficient should be given to Class 1, and similarly in the modern school the best should go to Class 3, because in these classes we have the widest variation, necessitating a good deal of group and individual work.

It is important to remember the difference between the mental age and the intelligence quotient. Whereas the M.A. indicates a standard reached, the I.Q. denotes a rate of development. A boy with an I.Q. of 100 develops at normal speed, so that his mental age and chronological age are the same. But a child whose I.Q. is greater or less than 100 progresses at a rate greater or less than normal respectively, so that the gap between his chronological and mental ages increases as he grows older. This is shown clearly by the following figures :

	C.A.	I.Q.	M.A.	Difference
(a)	7	80	5.6	-1.4 years
	11	80	8.8	-2.2 years
(b)	7	120	8.4	+1.4 years
	11	120	13.2	+2.2 years

The younger the children are, the less widely scattered are their mental ages likely to be. A difference of one year in mental age is represented by I.Q.'s of 90 to 110 at five years of age and by I.Q.'s of 96 to 104 at fourteen years of age. This should be remembered when a school is being organized.

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### INDIVIDUAL AND GROUP TESTS

The Binet tests are applied to each child individually. When a large group of children is to be examined this takes a very long time. In order to overcome the difficulty, tests have been invented which can be applied to many people simultaneously; these are commonly referred to as "group tests of intelligence". Tests of this type were first used extensively in the American Army during the 1914-1918 war to distinguish the dull recruit from his brighter colleague, in order that the dullest could be used in such a way that they did not impair the efficiency of the Army, and so that the brightest could be trained as officers. Two tests were used: the "alpha" tests for those who could read English, and the "beta" tests for illiterates and foreigners. The results obtained showed a normal distribution and, by adjusting the mean to be 100, it was possible to calculate the I.Q.'s. Subsequent work has developed tests of this type so that they now are fairly reliable tests of general capacity. The most famous of these tests in Britain are those prepared by Professor Sir Cyril Burt, the Moray House tests devised under the supervision of Professor Godfrey Thomson, the Simplex test, and those of the National Institute of Industrial Psychology.

Group tests are usually employed as a general test applicable to all children in an age-group. Where, according to such a test, a child seems to have a very low I.Q., it is advisable to supplement this test with an individual test. As the application of an individual test requires special training in addition to a gift for winning a child's confidence, these tests are usually given by a psychologist or a medical officer. Certainly the decision as to whether the child should go to a special school or not should depend upon such a trained officer, but there is no reason why the class-teacher should not apply individual

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tests for internal use in the school, for the class-teacher usually has the confidence of the children and many can easily acquire the necessary skill and experience.<sup>1</sup>

The individual test requires to be applied by a trained tester because it is more subjective and personal. Nervous and introverted children may be more disturbed by it than they are by the group tests, and it has been said by P. E. Vernon<sup>2</sup> to measure "an unanalysed hotch-potch of abilities", and it "has been severely criticized by Spearman, Cattell, and others on account of the weaknesses of its statistical construction and theoretical foundations". On the other hand, group tests are usually considered to be "highly saturated" with "g". Nevertheless, trained psychologists almost always prefer to use the Binet test, because it gives the tester a chance of observing the child carefully whilst he is doing the test. Low scores can arise from a variety of causes other than low intelligence, and testers are sometimes able to notice these abnormal causes and make allowance for them. The effect of the child's educational background, for instance, can be seen readily: if he shows poor verbal facility the tester can take this into account in his final assessment, which will be based mainly upon non-verbal tests; if he displays an emotional reaction prejudicial to his success in the test this can be noted, and steps can be taken to mitigate its influence upon later sections of the test. An experienced tester can usually break down quickly any resistance or dispel any nervous reaction. In addition, the tester learns much about the child other than the information about his "intelligence". Moreover, group tests often yield remarkably discrepant results. It sometimes happens that the correlation

<sup>1</sup> The first thirty applications of the individual tests should be for practice only, for the results are likely to be inaccurate and the tests will take too long.

<sup>2</sup> "The Measurement of Abilities."

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between two different tests is no more than  $+0.7$  or  $+0.8$ , and the scores of a single child may vary by as much as thirty points on two different tests. The conclusion of the experts is that group tests are valuable for measuring groups of people, and therefore can be used in comparing classes or sections of a class or in large-scale experiments, but that the I.Q.'s they assign to individuals must be treated with some caution. For the measurements of general mental ability the individual test applied by an experienced tester is more trustworthy.

### THE CONSTRUCTION OF THE TESTS

When constructing a test the psychologist bears in mind what is meant by intelligent behaviour in contrast to stupid behaviour. He considers the general characteristics of an intelligent man, such as those noted by Professor R. S. Woodworth.<sup>1</sup>

1. "He makes more use of his past experience than the stupid man.
2. He adapts himself better to novel situations than does the stupid man.
3. He takes account in his actions of a broader situation than the stupid man,  
that is, he pays attention to the whole situation rather than to part of it".

With these as criteria the tester selects the situations or questions which he is going to use.

At the same time he must make sure that he is measuring innate capacity for intelligent thought rather than any specific ability, any quality of disposition such as perseverance, or any direction of interest, all of which tend to modify our behaviour in such a way that acquired

<sup>1</sup> "Psychology," p. 24.

experience may often be mistaken for inborn capacity by the unwary. Unfortunately it is impossible to isolate " $g$ ", for it always expresses itself through some knowledge or acquired skill. It is essential, therefore, that the questions chosen should use such acquirements as are available to all persons. In order to estimate the "saturation with  $g$ " of the tests, the psychologist correlates the sub-tests and test items with one another to discover the internal consistency of the test. If correlation is high, then it is evident that the tests contain a general factor.<sup>1</sup> If we represent each item as  $g +$  a number of other factors ( $S$ ), then if the correlation between  $g + ns$  and  $g + ms$  is  $+1.00$ ,  $ns$  and  $ms$  are valueless; if  $r = +0.90$ ,  $ns$  and  $ms$  are very small, and so on.

Tests are usually prepared in duplicate. Both tests are applied to a sufficiently large population and the scores on the two tests are correlated. If this correlation coefficient (in this instance usually called the reliability coefficient) is less than  $+0.90$ , then the tests are not trustworthy. The two forms, if they are found to be reliable, are useful because the second can be used for testing the results obtained on the first.

Tests are constructed to apply to children within a limited age range. When choosing a test, the teacher should make sure that it covers the probable mental age range of the children to be tested. A good test provides norms (that is, a list of the mean marks which will be obtained by children of given ages) for the age range of the test, and the predicted mental ages of the children should fall within this range. If a test is advertised as suitable for children of 8 to 12 years of age, it will only be of use in testing a child of 8 if the advertisement refers to chronological age, for children of 8 chronologically may differ widely in mental age. In addition, the experienced

<sup>1</sup> See p. 129 and footnote, p. 74.



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teacher will look at the norms carefully to see if they are well spaced out. If they are spaced as follows,

Mental age	8	9	10	11	12	13	14	15
	yrs.	yrs.	yrs.	yrs.	yrs.	yrs.	yrs.	yrs.
Mean score	47	49	56	65	76	85	91	96

the limits of the usefulness of the test will be from 9 years to 14 years mental age. Any estimate outside this range cannot be relied upon, because the scores are too near those of the 9- and 14-year-old children.

In order to eliminate chance as much as possible, the child is presented with a large number of situations, so that any one situation which may be outside his experience counts for very little in the final assessment. This seems to set a premium on speed, because there are many questions to be answered in a limited time. Generally speaking, the idea that there are children who are slow but sure is false, for quickness in dealing with a situation is a sign of general ability. But this is not always so, and some children will be adversely affected. If a teacher suspects this, the child should be re-tested, and a test should be used which does not depend upon the time factor. In an endeavour to meet similar charges—for instance, that some children write more quickly than others—most group tests are printed in such a way that all the children have to do is to underline words or put crosses and circles in certain spaces. They should not be allowed to use rulers and rubbers, for these waste time. They should be told to cross out clearly any wrong answer, and should be provided with at least two pencils.

Each test usually consists of a battery of some four to twelve sub-tests, each with from ten to twenty items. These are arranged in order of difficulty, so that the child meets the easiest problems first. In order to make the child familiar with the situation, a short test which is not marked, usually called a "shock-absorber", is given

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first, and at the beginning of each sub-test one or more examples are worked for his guidance. Often the test is divided into three sections, and in each section are examples of the same sub-tests, each section being slightly more difficult than the previous one. This method has the advantage that the duller child meets all the easy work first, and does not spend time reading through and trying to puzzle out the harder questions, with the result that he gives up before he reaches the last of the easy questions.

It is essential, too, that there should be variety in the questions, so that various types of mental processes are included. Here are examples of some of the types of question that occur in these tests :

1. Analogies—*e.g.*, Black is to white as true is to (evil, false, traitor).
2. Synonyms—*e.g.*, Ill means the same as (sad, sick, old).
3. Antonyms—*e.g.*, Good is the opposite of (best, unhappy, evil).
4. Mixed sentences—*e.g.*, Through air birds fly the.
5. Classification—*e.g.*, Chair, table, rug, curtain, wheat (in this example the child will underline the one that is different from the others).
6. Series—*e.g.*, 1, 2, 4, 8, 16, —, 64.
7. Codes—*e.g.*, If IT WAS A MAN = JU XBT B NBO what is XIP BSF ZPV?
8. Inferences—*e.g.*, I started from the church and walked 100 yards.  
I turned to the right and walked 50 yards.  
I turned to the right again and walked 100 yards.  
How far was I from the church?

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9. Reading of instructions. This occurs in most questions but is often tested by reference to the alphabet—*e.g.*, If *S* comes before *Y* and after *V* write *O*; if it does not, write *N*.

These tests depend to some extent upon the factor verbal facility, (*gv*). This makes them unsatisfactory when very young children or children who are backward at reading, as a result of absence from school for example, are to be tested.<sup>1</sup> To meet this difficulty non-verbal tests have been devised.

The commonest type of non-verbal group test presents pictures and diagrams to the class instead of words, and the children are asked questions about them by the teacher. These are typical :

1. Draw a line from the cat to the mouse.
2. Put a cross under the picture which has something missing.
3. Simple mazes.
4. Selecting named objects.
5. Obeying instructions—*e.g.*, If the cat is bigger than the mouse, draw a ring round the cat.
6. Pointing-out what is wrong with pictures.
7. Riddles—*e.g.*, What things have wings, and live in trees (cats, birds, squirrels, mice).
8. Finding objects similar to one which is pictured.
9. Pick out one object which is different from the others—*e.g.*, a cat amongst three or four birds.
10. Arranging a series in order—*e.g.*, autumn, spring, winter, summer.

It is quite probable that these tests involve a specific factor also, the ability to deal with spatial relations (*gK*).

<sup>1</sup> Dr. A. F. Watts has shown that verbal facility may be influenced by the cultural background of the home (see pp. 25-6 of "The Language and Mental Development of Children"). Consequently "we cannot always be sure that justice is being done to children from homes where linguistic standards are low".

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Another type of test which tries to avoid the verbal and number factors is "the performance test". Tests of this kind usually consist of wooden blocks, form boards, and other solid objects which the child is asked to manipulate. The score depends upon the speed in performance or the number of moves taken. A single test is unreliable, so several should be used in conjunction. Some readers will be familiar with Alexander's "Performance Scale", which consists of a battery of these tests—the pass-along, the cube construction, and the block-design tests.

Alexander's tests are useful for testing children who have more facility in dealing with things than with words and numbers; but they can be applied only individually, and therefore need much time. For this reason they have not usually been so well validated as the verbal group tests. Correlation suggests, too, that they contain a large specific factor,  $gF$  (see p. 136), in addition to " $g$ ". But they are very attractive to the children, and they reveal certain qualities of disposition, such as perseverance and self-confidence, to the tester. Nevertheless, they must be regarded as still in the experimental stage.

## THE APPLICATION OF THE TESTS

Group tests are applicable normally to children with a mental age of 8 years or older. Below this age there are obvious difficulties. The most important is that such a test as we have envisaged depends to a great extent on the child's ability to read and to write. By 9 years of age most children are so familiar with formal schooling, with reading instructions, and doing class work, that a normal group test is fairly reliable. The verbal facility required is a good test of general scholastic ability; but tests involving this factor would be unfair for children under 8 years of attainment age, and their different educational environment would weigh adversely against

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some children and in favour of others. If we require a measure of general ability for those under a mental age of eight, it is much better to use an individual test. But we are faced at the chronological age of 7+ (mental ages about 5 to 9) with the problem of classification. The task of applying individual tests to all children would take a very long time, and could not be organized without the assistance of persons specially appointed for the job. It is usual, therefore, at this stage to use a non-verbal group test.

Since it is essential to apply tests to the children on more than one occasion, it is suggested that the following are the most suitable times in the child's life.

1. A non-verbal group test applied at 7 years of age, while the child is still in the Infants' School. At least the children who are placed at the bottom of the scale by the group test should be examined individually.
2. A group test at 9 years of age, when a test involving scholastic skills may be applied.
3. A group test at 10 years of age. This test will probably be applied together with attainment tests in Arithmetic and English before the children are selected for their secondary education. It should be noted that by this time the selectors will have three measurements of general ability recorded to help them in their decisions.
4. A group test at 13 years of age. This may precede the allocation of pupils to technical schools, if this takes place at 13+, and should be applied before the time when transfers from one type of secondary education to another are arranged.
5. A group test at 15 years of age. In secondary modern schools this test should be administered just before the end of the school life.

Different tests give slightly different results. For this

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reason it is a good plan for all the schools in one area to arrange to use the same test for each age-group, so that all the scores in the area are relative. This makes administration easier.

When applying the tests the teacher must note carefully and adhere strictly to the instructions given with the test. These are usually simple and precise, but unfortunately are often misread or neglected. If the test is to be valuable, it is essential that all children should take it in the same circumstances, for, unless the situation is the same for all, the scores are not really relative. For instance, it is usual to give a copy of the exact words that the administrator should use. If the tester alters these in any way, or supplements them with his own comments, he is altering the situation. Similarly, if he repeats an instruction twice, when he is told he must not do so more than once, he is giving advantage to some children. Again, he must not imagine that the "shock-absorber" need not be administered because no marks are given for it; nor must he omit it because he is short of time, for the "shock-absorber" is an essential part of the test. The test should be accurately timed, and, in order to ensure this, the time of the commencement of the test should be written down. In some tests, especially those applied to infants, there are gaps between the sub-tests, since young children cannot work for long at a stretch: to time the sub-test, a stop-watch is almost essential. The tester's attitude will also play an important part; he must be neither excited nor bored. He should show enough interest to encourage the children to look upon it as a pleasant kind of game. Above all, he must not suggest to the child that it is of vital importance and that his fate hangs on it. The children should be allowed to work silently and without interruptions; there are some teachers who cannot resist pointing out mistakes, talking

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to the children, or looking over their shoulders whilst they are working. In these days it is almost impossible to avoid some distraction; nevertheless, the tester must aim at ideal conditions.

When applying an individual test it is most important to put the child at ease by a preliminary conversation on matters of general interest. At this time, and throughout the test, the tester must be ready to notice any peculiarities of behaviour in the child which may be prejudicial to his performance in the test. Signs of tiredness and of nervous strain must be met with appropriate action. It may be necessary occasionally in the course of the test to stimulate interest again by returning to the conversational mood. It is obvious that the tester should give as much as possible of his attention to the child; consequently it is a great advantage to him to know the questions by heart and to arrange to make notes and to score at times when the child is busy with the problems or during general conversation. At all times the child should be encouraged, but this does not mean that the tester should ask the questions in such a way as to suggest the answers. He must be kindly, but impersonal. There should be no one else present at the testing, as this may cause considerable distraction to the child. From a test conducted in this way the tester will not only find the child's I.Q., but he will also gather much valuable information concerning his personality and interests, which will be useful in making decisions about the child's future education and occupation.

The scoring of the test is usually a simple matter, but it is necessary to emphasize that the key must be adhered to strictly, even though the tester may not agree with some point on it; if personal opinion is allowed to function, the test is altered. All scoring should be checked. The raw score obtained by checking the number right, or

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in some tests the time taken, is then transposed into the I.Q. There is usually a hand-book supplied with the tests which gives a table of norms—established by administering the test to several thousand children—from which the I.Q. can be found.

There are other factors which influence the test result. These are ill-health, nervousness, tiredness, and qualities of disposition (such as low perseverance). But the extent of the effect of these factors upon a performance in a test has not been determined.<sup>1</sup> Experiments seem to indicate that the effect is slight; but these conclusions are based upon a comparison of the average tendencies of different groups. This does not mean that in individual cases there is no marked difference. Psychologists have no doubt that fatigue, sickness and dispositional factors influence the results in an individual test, and it is logical to presume that these factors modify children's performances in a group test. Vernon<sup>2</sup> seems to confirm this when he states that "test reliability is known to be low among unstable testees".

Since the introduction of group tests into the examination for selection for secondary schools there has been a tendency in primary schools to practise "intelligence" tests. There is no doubt that practice and coaching can improve performance. If a test is taken soon after a similar one, then it is likely that the child's score will be increased by two or three points on an individual scale, and probably by more on a group test. One psychologist has suggested that it may make a difference in individual cases of ten points. On the other hand, it is probable that, if the test is dissimilar to that in which the child has been coached, the score of the child may be less than it would

<sup>1</sup> "To date, insufficient attention has been paid to the different emotional attitudes aroused in different children with test items and test situations." F. J. Schonell: "Backwardness in the Basic Subjects," p. 13.

<sup>2</sup> "The Measurement of Abilities," p. 190.



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have been without coaching. It is evident that coaching and practice to some extent defeat the ends for which the tests were originated, and they are therefore to be deplored. It has been suggested, however, that, since the scores on these tests merely indicate the relationship of one child to other children of the same age and sex, the difficulty can be overcome by making sure that all children should be given practice in "intelligence" tests.

### ASSESSMENTS OF INTELLIGENCE

As a check on the scores obtained in the tests, an assessment of the child's intelligence by the teacher is often useful. Such assessments are particularly valuable in the infants' department, for tests of general mental ability are not so reliable at this stage as they are later. In making the assessment the teacher should take into account evidence from as wide a variety of experiences as possible. The attainment of the child in his school work is important, but since it may be the result of other factors in addition to his general capacity, it is not sufficient in itself. Other points should be considered. The extent to which a child is capable of solving for himself the problems of his environment is a useful guide. His power to reason, to ask pertinent questions, and to give satisfactory answers to general questions are other indications of his mental ability. Fluency in speech may or may not be a sign of intelligence: if it consists merely of well-worn phrases and shows no freshness of thought it should be disregarded; but if it reveals control over vocabulary, readiness and accuracy in describing new situations, and a lively interest in everyday life, then it is likely that the child is highly intelligent. In infancy it may be safe to assess the child's "powers of observation" because his interests embrace most topics. Later in life, as we shall see in Chapter VI, his interests are more

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specialized, so that he observes only those things which interest him. Further guidance to his general mental capacity can be gained by noticing his powers of invention and of imagination. In the infant stage these powers will be observable in his drawings, his plasticine modelling, the stories he makes up, and his free activities. In later stages, where his work and play are more stereotyped, it will be more difficult to assess them. But we shall find them reflected in his literature and composition lessons, in his designs in drawing, in his capacity for solving mathematical and scientific problems. Obviously such an assessment, based upon so many points personally observed, will vary from teacher to teacher. Wherever possible a standard test should be used and the personal assessment employed as a check on the result.

### THE INTERPRETATION AND USE OF TEST RESULTS

Scores gained on tests of general mental ability must not be regarded as measurements on a par with those of height and weight—that is to say, they must not be given absolute values, nor should they be accepted at their face values. As we have seen, no intelligence quotient is entirely reliable. In the first place, a child's score should be regarded as the mean of his possible scores, which normally will have a mean deviation of  $\pm 3$  points. Secondly, the score indicates that in a normal population the child is likely to perform better than a certain percentage of his equals in age of the same sex (see Table 18, p. 80). Again, we saw (p. 83) that the scores must not be regarded as measures of the amount of intelligence that a child possesses, but rather, since I.Q.'s are ratios, as indications of the rate of development. A child with an I.Q. of 140 but with a mental age of eleven years is not so intelligent as another child with a mental age of twelve years, although the second child's I.Q. may be less, let us

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say 120; for the boy of M.A. twelve years will be superior in his school work and able to do more difficult tasks. But because the rate of development is different, the child with an I.Q. of 140 will gradually outstrip the child with an I.Q. of 120. In view of this, it is important for the teacher to know the mental ages of his pupils, because they will enable him to realize more clearly the type of teaching required. It is usual to regard a child with an I.Q. of 90 as below average, to treat him in the same way as the rest of the class, but to make allowance for his being below average by not expecting the same standard of performance. But if we say that the mental age of the child is seven years, we realize that he needs the methods applicable to a seven-year-old.

If the scores of any given child are found to vary by more than about four points—and this seems contrary to the personal assessment made by the teacher—a special test, preferably an individual test, should be administered, and the whole of the child's school record—that is, the sections on disposition, etc.—should be carefully inspected to see if any reason for the discrepancy is apparent. The mean I.Q. should be calculated together with the standard deviation. For example :

Age	7 yrs	9 yrs	10 yrs	13 yrs	15 yrs
I.Q.	94	97	98	91	100

Mean = 96. Standard deviation  $\pm 3.13$ . The final I.Q. should then be entered on the record  $96 \pm 3$ . Since the M.A. or I.Q. is likely to vary according to the test employed, the name of the test should always be stated.

The variation in a child's scores may be due to several causes: there are chance factors in every test which prevent it from being completely reliable; the tests are standardized on different groups of children, and this often results in a variation in the norms—British children, for instance, tend to obtain slightly higher scores on tests

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standardized in America than on those standardized in this country, and the same difference may exist between city and rural communities; some tests have a wider dispersion than others, so that the bright children are given a much higher score on one than on another and the dull children similarly are given lower scores on some tests; and the score may be affected by other factors, such as bad eyesight, ill-health, timidity. When considering any extraordinary deviation, the teacher should bear in mind these reasons.

There is one great principle which should govern all our work in testing: we must use our results as means to the better education of our children. The task of the teacher will always be to see that the child is doing work fitted for his intelligence. School work must never be much above or much below the capacity of the children. The greatest problems will always be the brightest and the dullest children. The bright children are often forgotten, and in consequence we find them restless and difficult to handle in class: the class does not move quickly enough for them and, having finished their tasks, they get into mischief. They require individual treatment. The case for the dull child is clearly put by Professors Oliver and Field.<sup>1</sup>

"Nature determines the potentialities of the child's intellectual development; it is for education to see that these potentialities become actualities. In some of the better special schools, children of limited ability who appear hopelessly dull to the inexperienced observer are trained in various useful skills and in general outlook and habits to make them useful members of society. When we compare with these children of approximately the same mental capacity who have not received suitable instruction and training, it is brought home to us how largely education is responsible for the development of

<sup>1</sup> "The Educational Guidance of the School Child," p. 46.

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intellect and character. There is a considerable danger that under ordinary school conditions the dull child will reach levels of performance which are lower than he could reach if curriculum and methods were more carefully adapted to meet his needs."

The teacher must therefore constantly adjust the standard and rate of work required to the class and to the individual. This may mean that the class will be divided into groups, according to mental ability. Consequently, when he receives his class for the session, the teacher should find the mean intelligence quotient (or better still the mean mental age) and the standard deviation from this mean for the class, and, in the manner indicated earlier in the chapter, separate the class into convenient groups. The syllabus and suggested rate of progress should then be adjusted in the light of this information and with reference to how far the subject is saturated with "g"—mathematics are highly saturated with "g", artistic ability is not.<sup>1</sup>

<sup>1</sup> Schonell: "Backwardness in the Basic Subjects," p. 51, gives the following table.

*Correlation Coefficient of School Subjects with General Intelligence for 100 Boys*

	General Intelligence.
Arithmetic: Mental . . . . .	+0.68
Mechanical . . . . .	+0.55
Problem . . . . .	+0.82
Reading: Recognition . . . . .	+0.51
Comprehension . . . . .	+0.65
Composition: Quality . . . . .	+0.61
Quantity . . . . .	+0.52
English Exercises . . . . .	+0.52
Spelling . . . . .	+0.53
History . . . . .	+0.58
Geography . . . . .	+0.51
Writing . . . . .	+0.21
Drawing . . . . .	+0.31
Handwork: Imitative . . . . .	+0.23
Creative . . . . .	+0.57

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During the session any marked deviation from the child's natural rate of learning, especially in subjects highly saturated with "g", should be noted. This can most easily be done by calculating the child's "achievement quotient"—that is, the ratio between his attainment in school subjects and his innate ability.<sup>1</sup> This calculation will reveal the deviations in those instances which are most difficult to discover: the boy who, although he is not doing the work of which he is capable, is well up to the standard of the class, and the boy who works too hard and puts undue strain upon himself in order to do work far in excess of his capabilities. Consideration of the other sections of the school records will usually reveal the causes of the deviations. They may be due to failing eyesight, partial deafness, malnutrition or some illness which results in lack of energy, loss of the will to work, and in absence from school. The child may lack interest or special aptitude. His weakness may be due to unsuitable teaching methods or to emotional difficulties which leave his "inner needs" unsatisfied. When the causes have been discovered, the teacher can devise ways of helping the child to overcome his difficulties. In this way I.Q.'s become a basis for educational progress.

We have already mentioned the use of the tests in selecting children for the type of secondary education most suited to them and in picking out the dull, backward, and mentally defective children for special treatment; for the I.Q. is a measure of the ability to profit by the particular form of education under consideration. It can also be of considerable use in vocational guidance, for it is an indication of the type of work which the child can undertake. It would be useless to suggest that a child of low general mental ability should become a doctor, a

<sup>1</sup> Achievement Quotient (A.Q.) =  $\frac{\text{Attainment Standard Score}}{\text{Intelligence Quotient}} \times 100$

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teacher, or a banker. When a teacher has considered a child's I.Q. in conjunction with other sections of his school record, he will be able to say with considerable probability whether a child will be happy in any given job or not.

Again, I.Q.'s can be used in the selection of comparable groups for experiments in educational problems, such as the value of different teaching methods. By means of the tests, two groups are chosen with equal ability and one group acts as the control group, taught in the normal way, and the other group is made the subject of the experiment. When the results are compared, we have a better measure of the success or failure of the experiment than we should have if the teacher relied merely upon his own impressions of his experience with one group, without another group with which to compare it.

We should remember that intelligence is but one factor in the development of the child, and that it has been pointed out often that "the defects of the intellectually subnormal are largely limited to the field of intelligence and . . . they should not be regarded as necessarily inferior in temperament and character."<sup>1</sup> We must accept the child's innate ability as a factor in his make-up, and not as a matter for condemnation or praise. Given his "intelligence" as a basis, we must endeavour to do all that we can to see that he develops his abilities and character to the full.

As a basis for the guidance of children in school, "intelligence tests" are more reliable than the old-style

<sup>1</sup> See article on "Subnormal Intelligence" in *British Medical Journal*, 15 Nov., 1947. Professor F. J. Schonell found ("Backwardness in the Basic Subjects," p. 23) that the correlation between general intelligence and emotional stability, to take one example, to be "little better than +0.35. There are numerous examples of mental defectives who are moderately well stabilised. Quite recently I examined a boy aged thirteen years who had an I.Q. of 37, but who was relatively stable in the expression of instinctive and emotional traits and who revealed an appreciable degree of development in common moral and social matters."

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subjective assessments of the teachers, which divided children into groups according to their cleverness, brightness, dullness, and mental deficiency; for these assessments often depended upon one or two incidents which stood out in the teacher's mind, or were influenced by the child's appearance, his behaviour in the classroom or the industry with which he applied himself to his work, with the result that teachers often varied widely in their assessments of the same child. The tests discount the personal opinion of the teachers, so that several teachers marking the same answer booklet would all get the same score. Again, in so far as they enable us to predict possible future progress, they perform a function which the ordinary school examination cannot do so well. But their usefulness is limited, because they are not precision instruments and because the scores revealed by them may be rendered false as indicators of innate ability by emotional disturbances, such as may be produced by a sense of inferiority, for example. Nevertheless, they are of great value to the teacher in almost every aspect of his work.



## CHAPTER V

# EDUCATIONAL ATTAINMENT

### SCHOOL EXAMINATIONS

TESTS of general mental ability cannot take the place of the ordinary school examinations ; for they do not indicate the educational standard which has been reached. Progress in school depends upon more than innate mental capacity. Health, special aptitudes, interests, willingness to work, self-confidence, the environment in which the child lives, and the quality of the teaching he receives, all play their parts. Because of one or more of these reasons, a child with a high intelligence quotient may achieve less than a child with a lower I.Q. Therefore, in order to be able to judge the work of which a child is capable at any given period of his life, we need, in addition to the test of general mental ability, tests of " educational attainment ".

Most schools already use tests of this type for periodical tests and examinations, to discover how much the child has learned and whether the methods employed have been successful. Teachers realize how valuable these tests are for indicating degrees of success and failure, because within certain limits they are usually effective.

But they have several weaknesses which make them unsuitable as measures of achievement. In the first place, scores on these tests are not related to the scores of all other children of the same age, so that, although they may be a basis for comparing the attainments of the different members of a class, they are not measures of standard attainment. They depend upon what the teacher of the class believes to be the achievement that should be reached at the given age. Secondly, this

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subjective weakness of the tests is emphasized by the admission of personal opinions into the marking. The tests are usually of such a nature that in some parts, at least, the marker has to rely upon his impressions, which may be influenced by chance factors; the style of handwriting, for example, albeit unconsciously, may influence the award. Again, the system of marking may vary from teacher to teacher: some will give marks in arithmetic only if the sum is completely correct, while others make awards, of varying value, for the completion of each of the processes involved. The difficulties in assessing the level of attainment in essay-type questions, such as are set in English, History, Geography, and other subjects, are well known and freely commented upon.<sup>1</sup> Marks assigned to the same scripts by different markers have often shown only slight correlation and in individual cases wide discrepancies. Vernon points out <sup>2</sup> that these discrepancies have been exaggerated, but at the same time quotes evidence to show that the correlation between the marks gained on two papers of two hours each on the same subject is often less than  $+0.70$ . In order to obtain a correlation of  $+0.90$  it would be necessary to take four such papers. What this means is clearly shown in a paragraph which is worth quoting: <sup>3</sup>

"Suppose that one hundred pupils take such an examination, with a reliability coefficient of  $+0.66$ , and that their range of marks is from 30 to 90, their average 60, and their standard deviation 12 marks. The P.E. of estimation of an individual mark will then be approximately  $\pm 6\%$ . Now if this is an examination in which the passing mark is fixed at 70 per cent, we can predict that all

<sup>1</sup> See in particular C. W. Valentine. "The Reliability of Examinations" and P. Hartog and E. C. Rhodes: "An Examination of Examinations."

<sup>2</sup> "The Measurement of Abilities," pp. 225 and 228-9.

<sup>3</sup> *Ibid.*, p. 225.

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those who scored 70 to 75 have an even chance of scoring below 70 per cent on a second similar paper, and that those who scored 64 to 69 have an even chance of gaining 70 per cent or more on a second paper. This means that only 10 of the pupils would pass according to both papers, 61 would fail in both, and as many as 29 would pass on the first and fail on the second, or vice versa."

Moreover, the ordinary school examinations rarely cover the whole field, and may concentrate attention on certain sections which happen to be one boy's strong point and another's weakness. Two parallel tests, set and marked by the same teacher and answered by the same children on consecutive days, have shown low correlation. Candidates have often been heard to remark that they did not like a paper because the expected questions, which they had prepared, had not been set, while their more fortunate colleagues had happily answered questions which they had "got up" the night before. Bad sampling in the questions may turn the order-of-merit topsy-turvy.

This enumeration of the defects of ordinary school examinations suggests ways in which they can be improved and indicates that their value is confined entirely to internal use in the school. A more objective, more reliable, more universally applicable test of attainment is required. Fortunately attempts are being made with considerable success to deal with the problems involved.

## STANDARD TESTS OF ATTAINMENT

The first requirement is to make the tests applicable to all children in an age-group, and this implies investigation into the basic knowledge which a child can be expected to possess in a given subject at any given age. Fortunately, there is substantial agreement on the attainment level which should be reached by the normal child in the first

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few years of his school life, and, on the basis of this agreement, tests have been evolved which have been carefully standardized by a thorough statistical analysis of their application to thousands of children.

In order to cover the whole field of the subject, so that the score will be a true reflection of the child's attainment, instead of a few questions requiring long answers, the test is composed of many short questions. Since to answer each of these questions only one operation is required, the marking can be done objectively. To a large extent they obviate cramming and the "spotting" of questions. In order to obtain a good dispersion of marks, so that they will be distributed normally, the questions are carefully chosen and arranged to cover evenly all levels of difficulty.

Some of the tests are arranged in such an order that the attainment age can be read off at a glance, for each problem correctly answered counts as one month. The sub-tests are arranged in ascending order of difficulty, and the child continues until he fails at four or five problems in succession. His attainment age is the number answered correctly. Thus if a child of chronological age 11 years 2 months reads all the words of age 10, three of those of age 11, and one of age 12, his reading age is  $10 + 3/12\text{ths} + 1/12\text{th} = 10 \text{ years } 4 \text{ months}$ . From this his Reading Quotient can be calculated

$$\text{R.Q.} = \frac{\text{Reading Age}}{\text{Chronological Age}} \times 100 = \frac{10.33}{11.17} \times 100 = 93.$$

Other tests consist of a battery of five or six sub-tests, each with some twenty questions arranged in order of difficulty. Each correct answer scores a point, and a raw score is calculated as a percentage. This is usually converted into a standard score, from which the attainment age can be calculated in exactly the same manner as we find the mental age from the intelligence

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quotient. A child of 10 years chronological age who scores 114 in an arithmetic attainment test would be capable of doing the normal work in that subject of a child of 11.4 years.<sup>1</sup>

Many such tests of varying degrees of validity have been published. Perhaps the most useful for teachers is Sir Cyril Burt's "Handbook of Tests for Use in Schools", which includes tests for reading (vocabulary, comprehension, continuous prose, etc.), spelling, dictation, and arithmetic, suitable for individual application to children above 4 years of age. Work on similar lines has been done recently by Professor F. J. Schonell and Dr. F. M. Earle.

Group tests of this type are useful when a local authority wishes to conduct an examination throughout its area at specified ages, for all results are comparable. They are often set at the age of 10+ to facilitate the direction of the child to the most suitable form of secondary education. Sometimes a preliminary test is given at the age of 9+, so that the authority can base its judgment on two performances. It is usual for the tests to be set by outside examining bodies with adequate experience and facilities for statistical checking. The

<sup>1</sup> It has been suggested that, since the marks gained on these tests are not to be regarded as being accurate and absolute measurements of attainment, they should be transposed into positions on the five point scale. The five classes would represent the percentages of the population and the standard scores given in Table 19.

TABLE 19

	Percentage.	Standard Score
A	Highest 5	Over 127
B	Next 25	110 to 126
C	Middle 40	92-109
D	Next 25	74-91
E	Lowest 5	73 and under

S.D. = 16.5.

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scores are expressed as standard scores, and may therefore be added to the I.Q.'s. The aggregate mark obtained in this way is an ability, attainment, aptitude score.

The separation of the children into different educational streams at 11+ makes it difficult to construct standard tests of attainment after this age, for there is no substantial agreement on the levels to be reached at particular ages, because the needs of the grammar, technical, and modern schools are all different. Although, in order to facilitate the transfer of pupils from one type of school to the other, they will all follow similar courses of study until the age of 13+, it would be unwise to apply a standard test to the whole area at this age; for during this period in the child's life special aptitude for certain subjects is beginning to make itself felt and interests are being developed, and, since it is usual to encourage the child who is favourably disposed to a subject by natural ability and inclination and not to worry unduly those who are not so fortunate, it is possible that the distribution of the measures of attainment reached at this age would not follow the normal curve. It may be possible to devise different attainment tests in the basic subjects each suitable for one of the three secondary streams; the School Certificate is in some measure such a test for the grammar schools. But at the moment the schools must experiment to decide their own standards and to construct their own tests. The following notes are intended to guide them.

### CONSTRUCTION OF TESTS

Schools should try to make the tests as reliable as possible. In the first place, they should see that all the ground is covered, and that each topic is given a number of questions relative to its importance. This can be done more successfully than is usual if a large number of small questions is set and if the teacher has arranged his

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syllabus in weekly assignments. In order to eliminate personal bias when considering the relative importance of different parts of the syllabus, it is advisable to have the test set by several examiners working together. The correlation between tests set to cover the same field in the same subjects by different examiners, each examiner setting a separate paper, as calculated from the marks gained by the same boys in answering the tests is only of the order of  $\pm 0.50$  and may vary from  $\pm 0.20$  to  $\pm 0.90$ . It is well, therefore, that at least the headteacher and one other teacher should be concerned in the setting of the test, and all the teachers in the school who teach the subject, whether or not they deal with the particular age-group which is being tested, should take part.

The test should contain questions of widely varying difficulty, so that there are problems that nearly everyone can solve, and some which only a few can solve; in between they should be so graded that the marks will be well distributed. If there is bunching of the marks, it may mean that the children tested are not a random sample, but it is more likely that it signifies bad testing or bad marking. If a question is set on work which has not been done, then the distribution will be skewed. This may seem an unnecessary warning, but it does occur. The lesson on the subject set may actually have been given, but it may have failed to reach its mark, because of constant interruptions, such as occur, for example, at the time of dental inspections.

The test should be so arranged that as little time as possible is spent on explaining to the children what is required, and as much as possible on the working of the test, for it has been proved that the longer the test, the more reliable it is. For this reason the types of sub-test should be reduced to about five or six. But there are limits to the length of time a child can work

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efficiently. Experiments by teachers to find the number and length of tests which give the most reliable results, would be valuable.

All questions of the same type should be grouped together in order to avoid the necessity of repeating instructions, and arranged in order of difficulty, so that the weak boy or girl will meet the simplest questions first. The examiner must decide what proportion of the questions is to be devoted to factual knowledge, definitions, maps, diagrams, and what proportion to the application of principles. These proportions will depend upon the outlook of the teacher; hence again the advantage of having more than one examiner.

The questions should be short, unambiguous, and such as can be answered very briefly, if possible by a word or a sign. In a good attainment test the child will be dealing with five or six ideas in a minute—in the essay type of question a child who gets down one idea in a minute is considered to be doing well. In order to cover so much ground, special types of question are used, the chief of which are the simple recall, the true-false, the multiple choice, the best reason, and the re-arrangement types.

In the simple recall type of question the examinee is asked a simple question, and records his answer in a space provided. This usually involves the writing of a word or phrase or a number, for the answer is not given by the examiner; it is "recalled" from the child's store of knowledge. It may take the form of a simple question:

*e.g.*, Who wrote "Paradise Lost"? .....

In what country is Montreal situated? .....

or of a sentence with some of the key words omitted:

*e.g.*, Boyle's Law states that if the ..... of a gas remains constant then  $\text{Pressure} \times \dots = \dots$

or of a map or diagram in which numbers have been used



instead of names or letters and the child is asked what each number denotes. This is a natural way of testing, but it is limited in its application almost entirely to knowledge which can be memorized, and it gives some advantage to children who can write quickly. There is the added danger that the question may have several answers which may be considered correct, but which may be of varied quality. For instance, to the question :

What does the word " delicious " mean ?

we may have a number of synonymous replies, varying from " nice " to " tasty ". This is an obvious example, and would be avoided by an examiner with a little experience ; but even experienced examiners do not always foresee possible answers.

To overcome the difficulty, questions of the " recognition " type have been set. In these, the task of the child is to recognize the true answer and to distinguish it from the false. These tests have the additional value that they can be answered by underlining the right answer, by ticking, or by some other simple form of checking, so that speed in handwriting does not influence the results materially. The simplest form of the recognition type is the " True-False " test. In this a number of items are presented to the child, and he has to indicate those which are true or correct by a + sign and those which are false or incorrect by a - sign. The items may consist of single words, as in a spelling test, or of sentences, as in a test of general principles, but the longer the item the greater is the danger of ambiguity and of misinterpretation by the child. This type has the added advantage that it need not be confined to factual knowledge. It can deal with knowledge which needs a sentence to express it ; that is, with mental processes such as reasoning and interpretation and the general principles underlying the subject concerned. But it is more liable to ambiguity and to the

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fault of suggesting the right answer in the wording of the statement; for these reasons the sentences should be as simple as possible—preferably with only one clause—negatives should be avoided, and there should be no attempt to “catch” the children unawares by some trick of detail. The greatest objection to this type is that the child who guesses is likely to score 50 per cent of the marks by mere chance.

In order to decrease the chance factor in the results, examiners have invented multiple-choice questions, in which a number of alternative answers, of which only one is completely correct, are given to the examinee, and his task is to choose the right one. If he has to choose one of three, his chances of being correct by guessing are less than they would be if he had to decide simply between right and wrong; if there are four items, the chances are even less, and so on. In good tests five items are presented. These tests have all the advantages of True-False tests and, at the same time, the chance of obtaining marks by guessing is considerably reduced. They are more difficult to set, for all the alternatives should be sufficiently near the correct answer to be selected by some of the children. The following examples illustrate this type of question:

In each bracket underline the one word which is correct:

- (a) The material we get from Ireland is called (calico, silk, satin, linen, worsted).
- (b) The colour of daffodils is (red, green, blue, yellow, pink).

The questions not only can check knowledge of facts but also, as the following example shows, can evaluate such matters as a sense of style.

The knight rode into the wood on his (palfrey, steed, horse, charger, mare).

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In this instance the child would be asked to choose the most suitable word.

A special form of this type is the question which asks for the best reason, a form which enables us to test the power of children to reason with and to make deductions from the facts they have learned. All the alternatives should have a grain of truth in them, but only one should be completely true. For example :

Put a cross opposite the best reason for the statement that " Ice floats on water " .

- (a) Because it is colder.
- (b) Because it is solid and water is a liquid.
- (c) Because it is less dense than water.
- (d) Because, if it did not, the fish in the rivers would be frozen.
- (e) Because it is composed of crystals and water is not.

Other questions may deal with the rearrangement of material. A list of items which normally fall into a certain order because they follow one another chronologically, spatially, or logically is put into a different order, and the child is asked to rearrange the items in their normal order. These questions can be useful in history and geography tests, and in examinations dealing with such matters as the procedure in scientific experiments. Some examiners have attempted to use them to test a child's power in composition by asking them to rearrange displaced clauses into sentences and disarranged sentences into paragraphs. The great difficulty is the scoring of such questions. Ballard's method was to give one for the first correct item and an additional mark for each item which correctly follows the preceding one. For example,

Arrange in historical order : Milton, Chaucer, Browning, Wordsworth, Pope, Shakespeare.

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If this was answered :

Chaucer,	Shakespeare,	Pope,	Milton,	Wordsworth,	Browning,
1	1	—	—	—	1

the child would score  $1 + 1 + 0 + 0 + 0 + 1 = 3$  marks.

The matching of items is a special form of this type. A series of items—for example, nouns or questions—are in one list, and in the other are descriptive phrases or answers respectively. The child is asked to fit appropriate descriptions to nouns or answers to questions. It is usual to have more answers and descriptions than items, so that the child cannot do the last two or three by a process of elimination. The difficulty with all these re-arrangement questions is that they involve some writing, even if key numbers are used.

An attainment test based on a battery of these different types of questions, although it has its weaknesses, can cover much more ground than the ordinary essay type examination, and can be marked much more objectively. Nevertheless it is better for the scripts to be marked by one examiner only, so that any personal error remains constant for the whole group of children examined. When papers have been marked and checked, the marks should be distributed to see if they follow approximately the normal curve.<sup>1</sup> If they are badly out, then it is probable that the test is a bad one, and it should be disregarded. Investigation into the distribution of marks on the various sub-tests will probably indicate where the weakness lies, and the paper can be amended. If the teacher is satisfied that the test is reliable, the raw scores should be changed to standard scores. Should a pass mark be fixed for any important purpose, then the scripts near the pass mark, especially those just below the fixed level, should be re-marked before a decision is made.

<sup>1</sup> See p. 51, "Goodness of Fit."

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### WEAKNESSES

It is objected to this type of test that children arrive at their answers either by a process of elimination or by guessing. In the former process the child may be able to rule out the answers which he knows to be wrong, and so presumes the remaining answer to be right, although he may not be aware that it is. This may not be a serious drawback, because it is based upon knowledge. But guessing is a different matter. In the true-false type of question the child has an even chance on each question of getting the answer right or wrong by mere guessing—that is, on an average he will get 50 per cent of the answers correct, and may even get 100 per cent correct, without knowing a single answer. By increasing the alternatives, as we do in the multiple-choice type of question, we can reduce considerably the chances of guessing correctly. Four alternatives instead of two reduce the average percentage of answers correct by chance to 25 per cent. To reduce the chance factor even further, some testers subtract the number of wrong answers from the number correct.<sup>1</sup> But these corrections are satisfactory only with the average person. They will still not affect the child who fits all answers correctly by guesswork. But it would seem that the fact that the children are not doing the test at random—that is to say, they are not merely guessing—reduces considerably the pure guesses, with the result that the scores are more accurate, and less dependent on chance, than theory would suggest.

But the chief objection is that these tests, consisting of large numbers of small questions, do not test some of the

<sup>1</sup> One-half the total wrong is subtracted where there are three alternative answers, and one-third where there are four suggested answers, where there are more than four alternatives no subtraction is made.

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abilities which help to make success in certain subjects. An English test on these lines, for instance, would fail to show the child's ability to arrange his material, his power of original thought or of imagination, or his control over language and thought in sentence structure. Vernon suggests that the older type of examination cannot measure these things either, for examinees do not display "organization of knowledge and original thinking. . . . Rat' er they dash down all the ideas and facts which they can recall, many of them irrelevant." Moreover, the mental processes of information and reproduction are highly correlated with understanding and thinking.<sup>1</sup> This is not a true answer; for children, when asked to pay attention to the arrangement of the material in their essays, do so, although with varying degrees of success. Vernon realizes that he has over-stated the case for the new-type examinations, for a little later in the same book he writes: "Yet they would probably never learn to write English at all if new-type examinations became the sole method of testing their abilities." This seems to be borne out by the information that has just reached us that a local authority which for a number of years selected its children for secondary education on a combination of mental ability and standardized attainment tests has decided to include an essay again this year, because the children entering the secondary schools in the last few years have been unable to compose good sentences or to write simple narratives. It is no doubt true that tests of attainment tend to dictate what is taught; for what is asked for in the examinations is usually over-emphasized in teaching. This is notably the case with the examination for selection for secondary education and the School Certificate examination. But the fact remains that the children who scored highly on the English attainment test

<sup>1</sup> "The Measurement of Abilities," pp. 251-2.

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were unable to write anything that could be called continuous prose.

It will be realized that both the old-type and the new-type tests of attainment are imperfect measuring instruments, and as yet there is no way of showing that one is more valid than the other; for we have no means of discovering an accurate measurement by which to judge them. But now that we know their weaknesses it will be possible by successive efforts to increase their reliability. Moreover, the two types of test are in some ways complementary, for some features of educational attainment can be tested better by one method, and other features by the other method. Subjects such as arithmetic can be reliably tested by the new type of test, but essay-writing cannot be treated in the same way. We recommend, therefore, that teachers should experiment freely with both methods.

A third measure should also be considered—the assessment of attainment on the five-point scale by the teachers. Assessments should be made before the tests are applied, in order that the teachers will not be prejudiced by the results, and, to increase their reliability, they should, if possible, be representative of the views of several teachers. The liability to error in an assessment of this kind due to personal faults of judgment and bias is well known, but taken in conjunction with the tests they should be helpful. Wherever the teachers' assessment differs widely from the test result, careful inquiry should be instituted.

## RECORDING ATTAINMENT

The record should contain a section in which the results of attainment tests may be entered. It would be well if spaces were provided for the Attainment Quotient, calculated on the basis of the score in each test, and for the

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personal assessment of the teacher. There should be facilities for brief comments on any discrepancies between the scores and the estimates, and for notes on any of the child's outstanding pieces of work, such as a piece of composition, a drawing, or an object made in the handicraft room. Strong and weak subjects should also be recorded.

At the infant stage we must rely on teachers' estimates, for it is undesirable at this age to test the children. But it will be helpful, when arranging the streams in the Junior School, to have assessments of attainment in oral and written expression, reading (mechanical and comprehension), number, and perhaps manual skill as shown in writing and handwork.

In order to make selection for secondary education more reliable—especially if we are to abandon the special examination—we should have at least two estimates made of a child's attainment whilst he is in the Junior School. Of chief concern will be the level he has reached in arithmetic and English. Standard tests should be used for estimating his progress in these subjects, supplemented by some written work of a continuous nature in English. Preferably the same tests should be used throughout the local authority's schools. If we are considering sending a child to a technical school, we should consider the teacher's estimate of his achievement in drawing and craftwork. Some teachers like at this stage to assess his attainment in spelling and in speech also. It is probable that no useful purpose will be served by recording his achievement in music, Nature study (or science), and social studies (history and geography). We have accordingly omitted them from the suggested record card which we print in the Appendix. But we have left spaces, so that the teacher may assess these or other subjects if he so desires.



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At the Senior Stage we wish to record a pupil's progress in most of his school subjects. As far as possible, standard tests of attainment should be used, constructed in the manner we have described. They should be applied just before the boy's course is decided at 13+, and, in order to help in the selection of his occupation, a few months before he leaves school. In addition, some head-teachers may like to have a test after the boy has been in the school one year.

### VALUE TO TEACHERS

Although not perfect instruments, attainment tests are very useful to the teacher. In the past important decisions were made, and much valuable information was revealed by the old type of examination, taken in conjunction with the teacher's opinion of the child. Our new instrument is somewhat better, and enables us to do with greater efficiency the jobs which the old examinations tried to do. In the first place, it reveals to us the knowledge gained by the individual child, even if this is confined merely to the questions set and to special aspects of the subject. This is some measure of his attainment and, in conjunction with his I.Q., indicates the effort he has made.

We must be careful to distinguish between the progress made and the level of attainment reached. A child may have worked diligently throughout the term and yet, because of his low capacity or lack of special aptitude for the subject, may not have reached a high level of attainment. If we wish to know whether his progress is satisfactory or not we should calculate his Achievement Quotient. Average progress is represented by an A.Q.

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of 100 ; a higher figure represents more than average and a lower figure less than average progress.

$$\text{A.Q.} = \frac{\text{Standard of Achievement}}{\text{I.Q.}} \times 100$$

*e.g.*,  $\frac{132}{110} \times 100 = 120.$

If we use the attainment age and compare it with the child's mental age, the efficiency of the child's work is often revealed even more clearly. A boy whose mental age is 11·6 years, but whose reading age is only 9·4 years, obviously needs special attention. The teacher should at once institute an investigation into the cause of the low reading age. In this way the attainment tests become not merely measurements of achievement, but also indications of difficulties which are hindering the child's normal development.

If we have a child's Achievement Quotients for a number of subjects we can notice their central tendency ; this will be some indication of his powers of application and of his powers of sustained effort in school work. This central tendency, although we must not consider it to be entirely reliable, may be a useful index, when taken in conjunction with other information about the child, of his probable future academic progress. Moreover, if interpreted cautiously it will reveal to us the child's willingness to work. We shall be able to distinguish the child who is indifferent, as far as school work is concerned, from the industrious child and—equally, if not more important—the child who works too hard. The remarks of Professors Oliver and Field <sup>1</sup> on these points are apt. “ While there are more than a few cases where children who ‘ slack ’ at school subsequently do well, it is broadly true that failure to develop good habits and attitudes towards

<sup>1</sup> “ The Educational Guidance of the School Child,” pp. 40–41.

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school work increases a pupil's liability to delinquency, shiftlessness, feelings of personal inadequacy, and other forms of social maladjustment.

"It is important to note that there are serious dangers to children in over-work; that 'laziness' may be nature's defence against a state of ill-health or unsuitable teaching; and that the healthiest worker is usually he who knows how to relax. Finally, teachers will agree that conscientiousness and orderliness should not be cultivated in such a way that spontaneity and originality are destroyed."

Again, when we consider the series of Standard Scores or A.Q's of a child it is possible to judge his strong and weak subjects. This information is of great value in planning his school course and in deciding his future career. In school it will enable us to place him in the most suitable group, so that the bright child can be advanced more quickly than his duller companion, and thus both may be kept happy and may retain their zest for school experiences.

The tests are valuable means of predicting future achievement, and therefore rightly play an important part in the selection of suitable pupils for the different types of secondary school, and for university education. By their means, in conjunction with other criteria, the child can be assigned to a suitable form on entry to the secondary school, can be guided into the most congenial school course, and, when he is about to enter the world to earn a living, can be placed in the most congenial type of work—professional, skilled, or unskilled.

It is valuable to a teacher to be able to compare his aims and methods with those of other teachers. If a standardized test is used, a teacher has an assessment of how the children in his class compare with the children of the same age throughout large areas of the

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country.<sup>1</sup> In this comparison the teacher has some measure of the syllabus he is following and the level of attainment at which to aim. By calculating the mean A.Q. for the form, based upon standard scores for such a test of attainment, the teacher can find a measure of the progress of the class as a whole, and this will give him some indication of the value of his general method. By examining the sub-tests in more detail, it is possible to discover which points of the syllabus have not been grasped, and these weaknesses can be given special attention in future lessons. It shows the teacher where his method was successful and where it must be changed or modified. He should make a careful note of all these points for future use. For instance, the teacher may have taught "The Air" as his week's work in science. A test reveals that the children remember the percentage of oxygen in the composition of the air, but that most of them forget the average height of the mercury in the barometer. The next time he takes the lesson the teacher should arrange to give sufficient further attention to the barometer. So used, attainment tests give valuable assistance in the improvement of teaching.

Perhaps it is as well to re-emphasize what has been so often stated. Tests of attainment may be helpful guides, but they are bad masters. In the form of certain examinations, such as the examination for the selection of pupils for secondary education and the School Certificate examination, they have been allowed to do much harm, with the result that there has been a great outcry against them. They have been allowed to distort the curriculum and to govern the syllabuses in schools; the subjects not required by the examinations have been neglected, and

<sup>1</sup> Low marks on a standard test do not imply that the syllabus of the teacher is necessarily inferior, for in different areas different operations, for example in arithmetic, may be taught in a different order. But they do suggest that the teacher should review his schemes of work carefully

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syllabuses have followed narrowly those set by examining bodies. The aim has often been not the development of the child, but the passing of examinations. The result has been "cramming", the learning by heart of opinions and ideas at second-hand from the teacher, the neglect of the power of thinking clearly and coherently, and the decay of the pleasure of discovery. Homework has been set too early in life and in such quantities that children have had little time for other activities, so that, although they may have passed examinations, they have missed much of life's joy. Tests of attainment thus used have often been the cause of maladjustment and physical illness. In short, instead of making an appeal to the interests of the child as the basis of his work, they have usually thrown such emphasis on to the competitive spirit that it has become unhealthy. These things have occurred, and it is for these reasons that people are asking for the abolition of the selection test and the School Certificate examination. On the other hand, it ought to be emphatically stated that these things ought not to have occurred. Good teachers take the examinations in their stride and, while helping all who are capable of doing so to clear the hurdle, refuse to attempt to drive over others who ought not to be taking the examination. It is difficult, in these days of fierce competition for the more lucrative posts and for the privileges of continuing education beyond the age of 15, to persuade parents that what is most important is that the child should be prepared for that part in life which he can play most happily, that he should be trained to value his experiences as far as he is capable of doing, and that he should be educated in such a way that he might have life, and have it more abundantly. Attainment tests wisely used stimulate the pupils and the teachers by providing an incentive to work; they are a measure of the abilities and character of the boys and

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girls. But, badly handled, they produce young men and women who have some learning, little understanding, less wisdom, and no desire to educate themselves further.

In this chapter we have been considering mainly academic attainment, but we must not overlook performances in other subjects of a more practical nature, where capacity is not so easily measured. We should assess the child's attainments in all subjects of the curriculum, including art, handicraft, domestic science, P.T., and games, if we are to give a complete measure of the child's educational level. For these subjects there are no satisfactory standard tests available, and in consequence teachers will have to draw up their own standard performances. P.T. and games, in particular, are neglected from this point of view by many schools, for there is a tendency to concentrate on a selected few boys and girls who represent the school in inter-school competitions. Attention should be given to all boys and girls by recording their attainments in these recreational subjects. In the Secondary School, P.T. should be assessed separately from games. Distinction in either subject—*e.g.*, membership of the first eleven—can be indicated, if desired, in another part of the record.

## CHAPTER VI

### SPECIAL APTITUDES

#### COMMON MISCONCEPTIONS

WE have seen that the performances of boys and girls will vary according to their general mental ability in conjunction with a number of other factors. One of these factors we call "special aptitude" for the subject or process which is being considered. For instance, a boy may perform very much better in one subject than in all others, or may attain a high level of achievement in all subjects except one or two. He is considered to have special ability in some subjects and to lack it in others. This difference in ability may depend to some extent on the variation in the boy's interest in the different subjects. But two boys with equal mental capacity and, so far as can be judged, equally interested in a certain subject, may show remarkably different ability in that subject. It is concluded, therefore, that one boy has an innate aptitude for the subject which predisposes him to success in it, while the other boy without this aptitude fails. Accordingly school-children, their parents, and their teachers refer to certain children as being "good" at certain subjects. Abilities in art and music are the clearest examples and are freely commented upon in ordinary conversation. For some children mathematics is a stumbling-block; they seem to be able to do well in all other subjects, but they cannot master this one. The difficulty which many people of high general mental ability have in obtaining the necessary qualifications in Latin for university entrance is well-known. It is evident that performances in these subjects are governed by

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specific factors which show themselves in the natural aptitude with which certain people undertake them and the otherwise unaccountable failure of some gifted people to master them.

The observation of this fact has led to a number of fallacious deductions. The general public, and indeed they were supported by some psychologists, believed that the mind was made up of a number of faculties, such as reasoning, judgment, imagination, memory, and so forth. Some people imagined that these faculties were like compartments which could be stuffed with knowledge, and even went so far as to pay "phrenologists" to read their "bumps", with a view to ascertaining the most likely line of successful development. People still wonder how one little head can hold so much. Attempts to define and measure these "faculties" scientifically have led to their being abandoned in favour of more tenable theories, such as that based upon instinctive behaviour by Professor W. McDougall or the modern factor theory. We must not fall into a similar error by thinking of these aptitudes as entities which we possess: they are to be regarded as convenient classifications for the description and study of the complex human personality.

A theory which seems to be founded more on human sympathy than scientific observation is the compensation theory. According to this, weakness in one direction is accompanied by a corresponding strength in another. The boy who is not good at book-learning is supposed to be good at manual work and, in consequence, instead of giving him textbooks, he is put into a workshop to do woodwork, metalwork, and craftwork. Similarly it has been suggested that the slow worker is sure. But the careful examination of many cases has not substantiated either of these claims. To take a clear example, the work of boys and girls in a school for dull and backward pupils is



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in all activities, on the average, below that of boys and girls who are average or above average in general ability.

Sir Cyril Burt <sup>1</sup> calculated the inter-correlations of thirteen objective tests of attainment set to 120 children aged 11+. The average correlation between each test and the other twelve is shown in Table 20.

TABLE 20

*Mean Correlation between One Test and All Other Tests*

Subject.	Mean "r."	Subject.	Mean "r."
Composition . . .	+0.505	Reading comprehension	+0.369
History . . .	+0.448	Writing speed . . .	+0.323
Geography . . .	+0.456	Writing quality . . .	+0.274
Nature study . . .	+0.458	Dictation . . .	+0.325
Mechanical arithmetic	+0.283	Drawing . . .	+0.275
Arithmetical problems	+0.457	Handwork . . .	+0.320
Reading fluency . .	+0.323		

It will be noticed that the coefficients are low. This is to be expected, for otherwise the tests would measure the same ability; they suggest that each test measures a specific ability. But the tests are positively correlated. This may be partly due to the influence of the factor *g*, general mental ability: but the positive relationship shows that performance in the different subjects is not inversely related—that is, that inability in one subject is not compensated by ability in another. The subjects which demand some manual dexterity (handwork, drawing, writing speed, and writing quality) have the lowest average correlations, with the exception of mechanical arithmetic. Although, if the manual subjects had been equal in numbers to the academic subjects <sup>2</sup> the coefficients would

<sup>1</sup> "The Distributions and Relations of Educational Abilities," *British Journal of Educational Psychology*, IX, pp. 45-71.

<sup>2</sup> The inequality increases "r" for the academic subjects, and decreases "r" for the manual subjects; for the coefficient is an average of 12 "r"s and there are more academic than manual subjects.

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be spread over a narrower range, yet the evidence does seem to indicate a group factor of manual dexterity. The low coefficients suggest that, whilst in general the children's performances were more or less the same in all subjects, and whilst a child who is above average in one is likely to be above average in the others, there are some children who are good at one subject and weak at another. The difference between the average correlations of the manual subjects and those of the academic subjects indicates that this difference between strong and weak subjects is more frequently between academic and manual subjects than between one academic subject and another, or between one manual subject and another. But there is no evidence for stating that a boy who is weak academically is likely to be good at manual work. He may be good, but more frequently he will not.

Similarly the correlations suggested by the figures between specific abilities and general mental ability imply that a child with high general mental ability is likely to have greater special aptitude than a child who is below average in general capacity, but that it is possible that we shall find boys and girls in schools for dull and backward children who have marked special aptitude for one subject or another. Owing to performance in academic subjects depending to some extent on general intelligence, it is likely that this special aptitude of the dull child will appear in some form of non-academic ability rather than in work involving book-learning.

## FACTORIAL ANALYSIS

So far, in order to clear up some common misconceptions, we have confined our remarks almost entirely to special ability in particular subjects, ability which may be measured to some extent by attainment tests. The difference between these abilities and special aptitudes

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is that, whereas "specific abilities" modify achievement in particular subjects, "aptitudes" occur in a group of performances, all of which are of a certain type. All performances in the group of subjects or activities correlate highly with one another, but lowly with performances in subjects or activities not in the group. To take an example, we have already suggested that the objective tests used by Sir Cyril Burt which involved the use of the hands had a common factor, manual dexterity. If this is a special aptitude, then the performances of boys and girls in one sub-test, for example book-binding, will show marked correlation with their performance in another sub-test, for example cardboard-model-making. Some children may be better at one activity than at the other, but in general their performances will be about level in each piece of work. But it is possible that the two tests correlate highly because of some other factor, perhaps general intelligence, which is common to both. If this were the case, then the correlation would not be due to any distinct factor, such as manual dexterity. We can, however, check this possibility, for the children can be given an intelligence test, and we can find how much the correlations are due to the factor "general mental ability", and how much to the factor special manual aptitude. The actual statistical work involved may be left to the specialists in that sphere, but a brief outline of the theory of factorial analysis may be helpful.<sup>1</sup>

No test is pure—that is to say, it does not measure one thing only. A test of general mental ability may measure not only "g", but also the verbal facility, the capacity to deal with numbers, and the ability to perceive relationships of the child. The results of a test of attainment, as we have seen, may depend upon "g", the disposition

<sup>1</sup> A teacher who wishes to pursue the subject should read Thomson G. H.: "The Factorial Analysis of Human Ability"

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of the child, the efficiency of the teacher, the physical condition of the child, and other influences. These components are called "factors".

If two tests show correlation, then certain parts of the tests overlap one another and they have common components or factors. A factor, such as general mental ability, which is common to most tests, is called a general factor, one which is common to a number of tests is called a group factor—for example, a number of tests involving the manipulation of mechanisms are said to measure the group-factor mechanical ability. That part of a test which does not correlate with other tests is said to be its specific factor; it may be due partly to errors in the test, but it represents a peculiar factor in the test. Thus two sub-tests in a battery of tests of general mental ability will not correlate perfectly, for, although they may both be highly saturated with "g", one will be better done by the child with greater facility with synonyms, and the other by the child with greater capacity in finding analogies: performances in both these tests will be correlated positively because they both involve the group factor, verbal facility, but there will not be perfect correlation because of the specific factor in each test. The arrangement of factors in an ability or in an individual is known as the "factor pattern". For our purposes we shall consider all tests as being of the pattern general factor + group factors + specific factors, since all other factor patterns are included in this. Thus a mechanical arithmetic test can be analysed into the general factor "educational ability"—that is, "g" plus application to and interest in school work in general—together with the group factor which enters into all arithmetic tests, and the specific factor of the mechanical arithmetic test which distinguishes it from all other arithmetic tests—for example, from the arithmetic problems test. It is possible, there-

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fore, by correlating a number of tests, to guess at their component factors. It is also possible by statistical methods to keep the general factor constant or to partial it out, so that we can discover the group factors in tests. This is important to us because these group factors are the measurements of special aptitudes. Thus we are able to determine objectively what are the abilities of man, and we can use them instead of the "faculties" and subjective impressions which psychologists have found to be unsatisfactory in describing mental characteristics.

But it would be well to remember the caution issued by Vernon.<sup>1</sup> "Factors are not entities in the mind whose nature or constitution, and whose strength and weakness, are immutably fixed." They do not reveal "the fundamental elements of which human minds are compounded".

### THE APTITUDES TO ASSESS

Much research along these lines remains to be done, but sufficient information is available for comment to be made on some of the special aptitudes postulated by various educationists. Circular 151 suggests that schools should be able to give sound information about skill in the use of words, skill in the use of numbers, and skill in practical activities—*e.g.*, drawing, music, and games. It mentions, as aptitudes which are less distinguishable at this stage, mechanical ability, manual skill, and the abstract understanding of spatial relations—(*e.g.*, in geometry). The National Foundation for Educational Research on its record card lists verbal facility, reasoning, speed of work, observation, practical ability, artistic ability. By the application of factorial analysis to the tests mentioned on page 128, Burt found that correlation was due to four group factors, in addition to general mental ability. The tests in each group showed considerable inter-correlation

<sup>1</sup> "The Measurement of Abilities," p. 160.

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which was not due to the general factor, and between tests of different groups there was little correlation. He concluded from this evidence that there were four kinds of educational ability in addition to the general factor.

1. An arithmetic factor (arithmetic problems and mechanical arithmetic).
2. A manual factor (handwork, drawing, writing speed and writing quality).
3. A linguistic factor (dictation, reading speed, and comprehension).
4. One including all the "integrative" school subjects (composition, history, geography, nature study).

Vernon <sup>1</sup> following Burt's method analysed the performances of training college students into three groups.

1. Practical—teaching skill, speech training, physical training.
2. Scientific—psychology, hygiene, arithmetic.
3. Literary—English, speech training, education, history.

It appears, therefore, that there are many special aptitudes. Since the measuring or assessing of them all would take up too much of the teacher's time, and since, as we shall see later, this work is impractical at certain stages of the child's development, we should consider which of these factors should be recorded.

A number of the suggestions can be discarded at once, as they are general factors which enter into general educational ability rather than group factors which indicate special aptitude. Among these are observation, reasoning, and speed of work. There seems little ground for considering observation as a distinct ability. In general we observe that in which we are interested. A man who observes carefully in a bird-sanctuary may walk along a

<sup>1</sup> "The Measurement of Abilities," p 158.

city street without noting anything precisely. It seems, therefore, that observation reveals interests rather than special aptitudes. Reasoning enters into all intellectual pursuits, and sub-tests of this nature form part of the test of general mental ability. It has been shown that speed is correlated positively with power; it seems, therefore, to be a characteristic of any special aptitude rather than a factor itself.

The term artistic ability is vague and probably incorrect. It implies that there is a group factor that indicates that a man's performance as a painter is related to his performance in the other arts, such as poetry, music, sculpture, and architecture. This has not been disproved: nor is there any satisfactory evidence to show its truth. Some artists have succeeded in several media, and it is probable that others would have done so if they had developed their innate abilities in different fields; but it is usual for an artist to concentrate on the one medium in which he is most interested. For the purposes of the school record it will be much more valuable if we record of the arts the interest taken in them (see next chapter). Special ability in music, or painting, or drama, should be recorded under attainment, although performances in these arts will be borne in mind when assessing group factors, such as manual dexterity.

Circular 151 mentions skill in the use of words as a special aptitude, and this is supported by the Foundation for Educational Research. Burt's evidence seems to suggest that there may be two distinct abilities here; for we find reading speed and comprehension in one group and composition in another. Some commentators have suggested that it is a distinction between the spoken word and the written word. We should do better to use Burt's classification and to distinguish between the ability to understand words and the ability to use them, for usually

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our reading vocabulary is much larger than our spoken vocabulary, and we can read with understanding passages which we could not compose ourselves. It may be that there is one "source" ability (verbal facility) which manifests itself as two "surface" abilities (comprehension of words, and ability to use words).<sup>1</sup> But these are only suggestions, and until they have been proved right or wrong, we must content ourselves with assessing the verbal factor, the child's ability to deal with words, denoted by the symbol "*v*" or "*gv*". We have no indication at the moment as to whether or not this ability is related to the ability in foreign languages. If a child shows a "flair" for languages, it should be noted in the record under "strong subjects".

Skill in the use of numbers is one of the most marked abilities, for we encounter many children who have outstanding facility in their manipulation and others who, although good in other subjects, cannot do arithmetic. Burt's evidence and that of other psychologists seems irresistible. The evidence we have suggests that this is a different group factor from that which shows itself in ability in science. Each science has its own specific factor, so that the correlation between performances in chemistry and those in physics or biology is not complete; but, generally speaking, a boy who does well in one natural science does well in the others. There is a suggestion that correlation between them in the case of girls is not so marked. It would be interesting to see the results of inquiries into this matter.

The attempt to make the curriculum fit the child has encouraged investigations into other special abilities. Of particular interest at the moment are special technical

<sup>1</sup> The terms "source" and "surface" are used by Cattell ("Description and Measurement of Personality") to distinguish between innate ability and that ability as it shows itself when it has been modified by experience.



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abilities. The need for technicians is leading to the establishment of technical institutions throughout the country, and has raised the problem of how to determine which pupils are most suitable for this type of education. It has been suggested that in the selection of children for secondary education the tests usually applied give some weight to the candidates with good verbal ability, and therefore are not entirely satisfactory in selecting children for technical education. For this reason attempts have been made, especially in America, to measure the abilities which, in addition to general mental ability, will be most useful to a technician. Consequently tests have been devised which aim at measuring practical ability, mechanical skill, manual dexterity, and the abstract understanding of spatial relations.

Circular 151 lists drawing, music, and games as practical activities. This is unfortunate, for the list may suggest a connotation not usually given to the word "practical" by psychologists.<sup>1</sup> It is generally used to mean the aptitude required in engineering workshop practice, pattern-making, and mechanical drawing. Drew<sup>2</sup> tentatively defines it as involving "mental exercises of the concrete order, with manipulation and handling of material, shape and pattern being perceived and appreciated in the course of performing such operations". The teacher should be careful to distinguish between this factor and manual dexterity. He will not go far wrong if he bears in mind Burt's four tests, in which the group factor manual dexterity occurs (see p. 133)—handwork, drawing, writing speed, and writing quality. Mechanical ability ("m" factor) is used to denote the special aptitude in handling mechanisms. Experiment has shown, too, that there is a factor which enters into tests involving

<sup>1</sup> The symbol for this factor is  $gF$ .

<sup>2</sup> L. J. Drew. "An Investigation into the Measurement of Technical Ability" in *Occupational Psychology*, XXI, 1 Jan., 1947.

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the abstract understanding of spatial relations, such as are met with in geometry. This is known as the "*k*" factor. Attempts have been made to measure this factor by group tests consisting of abstract diagrams, pictures, and other similar material; but the evidence seems to indicate that up to the age of 14 these spatial tests appear to measure general mental ability chiefly.<sup>1</sup> There would seem no point, therefore, in applying these tests before the children are 14 years of age, by which time most of the decisions which depend upon the knowledge of their special aptitudes will have been made.<sup>2</sup>

We must not overlook the possibility that manual dexterity and practical ability may depend to some extent on a possible underlying general factor, neuro-muscular co-ordination, which reflects our general ability to control our muscles by means of the underlying nervous mechanism, just as "*g*" reflects our general intellectual ability. Clumsy children are probably deficient in this factor, while gifted children have a delicacy of touch and gracefulness of movement which in some spheres of human performance—for example, dancing, seem to indicate the possession of an outstanding ability.

### THE AGE WHEN SPECIAL APTITUDES ARE REVEALED

The question of the age at which these special aptitudes develop is an important one. Usually they are slow to appear, for the normal child is most concerned with establishing the balance between himself and his general environment: consequently he has greater need for general mental ability. "It is, therefore, hard to forecast when a child is at the primary or early secondary stage of education, what level of performance he will ultimately

<sup>1</sup> Recent work at Moray House seems to indicate that the space factor operates in certain performances at the age of 11+.

<sup>2</sup> For accounts of experiments in these matters see J. W. Cox, "Manual Skill," Cambridge University Press

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reach.”<sup>1</sup> But some children show innate special ability earlier than others, and some aptitudes tend to appear early in the child’s development. In the realm of music in particular we hear of infant prodigies. But it is usually in the secondary stage that special aptitudes begin to show themselves. At this age a child’s strong and weak subjects become more easily distinguishable. But it is still very difficult to distinguish special aptitude from general mental ability or from the effects of good teaching coupled with a good attitude towards work. The teacher must be on his guard in these matters. The position is further complicated by the fact that in some children, owing to unfavourable environmental influences, their special abilities may not be noticeable until quite late in their careers: this often happens with verbal facility, which usually appears early, but may show itself late in adolescence. Indeed, the difficulties are so many that most people who have to select candidates for posts or for further education rely upon general mental ability and attainment tests as the only criteria. A good many rely upon the School Certificate Examination; the Civil Service set similar tests of all-round ability when selecting personnel. As we have seen, there are dangers in this method. But special aptitudes cannot come into the calculation as predictions of future capacity until we have found a means of assessing them. We must now turn to that problem.

### MEASURING AND ASSESSING APTITUDE

For some of these aptitudes, tests have been invented, such as those for manual skill and mechanical ability used by Cox.<sup>2</sup> Perhaps the best-known in England at present is Alexander’s Performance Scale, comprising the

<sup>1</sup> Circular 151. “School Records of Individual Development.”

<sup>2</sup> Cox, J. W.: “Manual Skill,” Cambridge University Press.

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Pass-along, Block Design, and Cube Construction tests. Drew<sup>1</sup> maintains that this scale does measure *F*, the practical ability factor, at 11+ and "*k*", the spatial-relations factor, at 13+. But Alexander's tests are individual tests and take a long time to apply—for each pupil about three-quarters of an hour is required. As was mentioned earlier, at the age of about 14 years, "*k*" can be measured by a group test consisting of abstract diagrams and other pictorial devices.

For the ordinary class teacher these tests are not yet practicable and, until such time as more serviceable tests are available, he will use his personal assessments on the five-point scale. In order to be as objective as possible, the assessment which appears on the record should be the result of a comparison of the assessments of as many teachers as possible. In making the assessment, the teacher should endeavour to bear in mind the performances of the boy or girl in the related subjects, for a comparison between the performances of a child in different subjects will reveal the comparative strength or weakness of his group and specific factors.<sup>2</sup> For this reason it is often useful to indicate first any strong or weak subjects in the manner indicated in the previous chapter. The assessments should be made annually, and special notes should be kept of any cases which have been particularly difficult to assess. It is best when assessing to attempt to compare the child with the rest of the child population of his age-group. We must be careful to distinguish special ability from interest in the subject. Generally the two go together, for the child is usually interested in what he can do well. But this is not always so. Consequently, it sometimes happens that, when the assessments of special

<sup>1</sup> "An Investigation into the Measurement of Technical Ability" in *Occupational Psychology*, XXI (Jan.), 1947

<sup>2</sup> See the section on "Paired Comparisons," p. 155

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aptitude are compared with the results in the attainment tests, they do not correlate highly. A child with perseverance and interest in a subject may, especially if his general mental ability is above average, achieve a high level of performance, even though he has little special aptitude for the subject.

We have seen that most special aptitudes do not show themselves in the first years of school life. There should be no attempt, therefore, to assess them in the Infants School, although, if a child shows outstanding special ability in any direction, it should be noted on the record. During the Junior School stage we should be able to assess a child's verbal facility, his aptitude for number, his manual dexterity, practical ability, and musical ability. These assessments should be some indication of the kind of education for which he is most fitted at the secondary stage. Later we shall be able to assess his scientific and mechanical abilities and his power to perceive spatial relations. Comments on his specific abilities should be added at each time of assessment.

The total assessments made on all children of an Authority should be checked with the normal distribution on the five-point scale. Any marked deviations will show either that the assessors have not understood the terms of reference or that the ability cannot be so measured. Table 21 shows the total assessments for all the children of the age 10+ of one local authority.

If we calculate  $\chi^2$  and  $P$  for these distributions, we shall find that their deviations from the normal curve cannot be ascribed to mere chance. There is overweighting at the extreme points of the scale. This was due in some measure to the unfamiliarity of the teachers with the five-point scale. It is interesting to note that there was widespread criticism by the teachers of the aptitudes chosen.

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## TABLE 21

*A check on distribution of assessments of special abilities  
[a one-year group of a Local Education Authority]*

	Distribution					Per cent deviation from normal distribution					Mean per cent deviation.
	A.	B.	C.	D.	E.	A.	B.	C.	D.	E.	
Expect 1 . . .	153	765	1224	765	153						
Verbal . . .	251	800	1217	657	149	+64	+7	0	-13	-3	17
Reasoning . . .	202	721	1212	717	212	+32	-6	-1	-2	+38	16
Speed of work . . .	164	667	1265	757	221	+7	11	+7	1	+14	14
Observation . . .	206	780	1371	588	129	+54	+2	+10	23	16	17
Practical . . .	184	826	1573	540	120	+20	+9	+12	30	22	18
Artistic . . .	173	725	1131	573	135	+13	-5	+17	-26	-12	14
Mean . . .	197	756	1308	644	111						

## THE APPLICATION OF THE ASSESSMENTS IN GUIDANCE

The value of these assessments of special aptitude lies in their help in forecasting the future career of a boy or girl. When deciding the type of secondary education he should follow, the school course he should undertake, or the future occupation he should enter, we can suggest the general level of the work or studies of which he is capable by stating his general mental ability. But, unless we have a knowledge of his special aptitudes, we cannot predict whether he will be successful or not as an engineer, a chemist, a lawyer, a carpenter, an artist, a plumber, a cook, a farmer or in any other trade or profession. At the present day there is still much use made of the method of trial and error, although more and more headmasters and juvenile employment officers are endeavouring to give guidance based upon subjective assessments of disposition, aptitudes and interests, in conjunction with attainment tests and measurements of general mental ability.

Fortunately, general ability is a useful rough guide to

success or failure in all fields. Experiments so far conducted seem to show that special aptitudes are correlated positively with "g", so that, in general, a boy who is above the average in general ability will be above the average in any special ability (see p. 128). This means that the average man is capable of adapting himself to his environment, and can be trained to do most tasks adequately. We had many good examples of this during the last war: bank clerks became pilots, shop assistants commanded tanks and guns, and women left the hearthside to manage lathes and to do many jobs which previously only men had undertaken. But this applies to the average man and woman, and there are many who are above or below average in some special aptitude and who cannot adjust themselves to their environments. We are concerned particularly with those children who, having special aptitude in one ability, feel a sense of frustration because they are never allowed to pursue it, and with those other children who, having no ability in a subject, are yet expected to do well in it, and who suffer great misery in school and in after life because of a wrong decision. As life becomes more complicated, adjustment becomes more difficult. The problem is very important. Much research is needed before we can make guidance really scientific, but with the knowledge we have at the moment it is possible to do much. The teacher may feel dissatisfied because so much depends upon his subjective assessments. That will lead to thought and to experiment which will in time give us more objective and more precise measures of these special aptitudes.

We are coming nearer to the solution of the problems involved in the selection of children for the different types of secondary education. The tests usually applied are fairly reliable forecasters of success in the type of education given by grammar schools, and much progress has been

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made in finding tests to predict technical ability. Drew<sup>1</sup> has shown that "the performance scale . . . correlates substantially with success in the Junior Technical School Diploma Examination", that "there is some evidence to show that the psychological factors which are significant for technical aptitude are 'g', 'F' and 'k'", and that "Selection of boys for technical education can be facilitated at 11½ by using the performance scale as a measure of technical aptitude, in addition to tests of general and verbal ability". The system recommended by Drew is first to select the children of superior intelligence by means of a test of general mental ability. From these, the children whose verbal ability score was significantly higher than their practical ability as measured by Alexander's scale should go to the grammar school; those whose practical ability was significantly greater would go to the technical school. In addition some consideration would be given to interest and dispositional traits. Those who have adequate general ability but whose verbal ability and practical ability seem about equal would be assigned places by reference to their parents' wishes, their own interests, and their dispositional traits. The great drawback to this scheme is that it would require the application of the Alexander scale to a large population.

Within a school there is usually much time and energy wasted because children are studying the wrong subjects or because they are badly grouped. As a result of the experiment which we have mentioned earlier (see p. 128) Burt suggested that the children should be arranged in classes according to their attainments in the "linguistic" and "integrative" subjects, and that for arithmetic and manual subjects they might be rearranged into different

<sup>1</sup> *loc cit* Other research workers, however, have not found significant correlation between the test and examination success. More research is needed to clarify the position.



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groups so that each group had a smaller spread of ability. Eventually we may be able to assign a boy or girl to the most suitable course, arts or science, engineering or mechanical, commercial or manual. It should be possible for us, too, to plan the courses in all subjects so that the child of very little aptitude is not expected to keep up with the gifted child.

It is important to remember when considering aptitude the children who suffer from disabilities. A "tone-deaf" child is incapable of musical appreciation and performance. Some children have special difficulty in learning to read, in spelling, in handwork, in mechanical arithmetic, in language, in science: for each specific ability there is a corresponding specific disability. Any disability should be noted carefully by the teacher when the assessments are made, for sometimes much can be done to help the child. A boy with good general ability can learn to read satisfactorily, even though he may have a reading disability. In some instances the specific backwardness may be the result of some emotional conflict. Whenever a child is found whose performances in one or two subjects are notably below those in other subjects, there is a challenge to the teacher to discover the cause of the disability.

It may be possible also to find which group factors are common to certain school subjects and certain occupations. Researches in factorial analysis of ability in the worlds of business, commerce, and industry would give us valuable information, which would help us in suggesting the kind of occupation most suitable to a boy or girl when leaving school. The vocational guidance of adolescents is very difficult and still contains too many chance elements. The best means we have at the moment is to consider the level of a child's general mental ability in conjunction with his interests, his standard scores on

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attainment tests, and the teacher's estimates of his special aptitudes.

It is clear that a great amount of research on special aptitudes must be done before we can say with certainty what factors there are, before we can measure them with any accuracy, and before we can use them as precise evidence in forecasting the development of children.

## CHAPTER VII

### SPECIAL INTERESTS

#### THE IMPORTANCE OF INTERESTS

It has often been suggested that one of the most important factors in the success or failure of a boy or girl at school or of a man or woman in life is interest in the task undertaken. Indeed, so firm is the belief of some educational theorists in this idea that they declare that, if the teacher succeeds in arousing the interest of the child, then all educational aims will be achieved. But a moment's thought will show us that attainment and interest do not necessarily go together, for, as we saw in the last chapter, success depends upon other factors, such as special aptitude for the subject or activity concerned. We have all endured the efforts of the ungifted soloist who is so interested in his songs that he wants to sing them all too frequently. There are many keen sportsmen who, if interest coupled with training could produce results, would be first-class performers, but, alas, they have not the innate ability. As Circular 151 says, "Aptitude and interest often, but by no means always, go together." On the other hand, we know many people who have inborn capacity to do well in some sphere of human activity, but who are not interested enough to bother about it. How frequently do we read on reports, "He could do much better, if he would show more interest in his work"!

Interest can do much, for it gives vitality to all activities. It produces a pleasurable excitement, coming from the satisfaction of instinctive drives, and the content of mind which derives from the feeling of self-fulfilment. When interest is aroused in a man, he forgets much that is

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irksome and becomes alive to the situation, so that he remembers it clearly. A man will stand in the bitter cold weather to watch a football match; a woman will endure the discomforts of a crowded departmental store on a bargain day; the craftsman works for long hours uncomplainingly. All these people have a sense of joy, which enables them to put forth great energy without a sense of exhaustion. When work becomes play, achievement tends to increase and happiness ensues. It is for this reason that it is important to arouse interest in school work: it enables a child to put forth his best efforts, without which his special aptitudes may not grow to their fulfilment. "So it is for most of us" writes Dr. Watts;<sup>1</sup> "all the things that interest us are animated and coloured by our practical relations towards them. They incite us to the mastery of whatever there is to be known about them. They supply the halo of wonder and romance which lifeless information lacks. They beckon us on to distant horizons and arouse in us the continuing energy to reach them. Fortunate, indeed, are the children whose teachers are able to inspire them with such interests and at the same time provide the opportunities for their satisfaction."

But it has another importance today. A good deal of modern work has become drudgery; the worker too often has no chance of impressing his personality on his materials, of taking pride in his dexterity, or of finding self-satisfaction in the making of something from beginning to end. Consequently he rushes to the football match and to the greyhound racecourse to attempt to stimulate artificially, by a gamble, his stillborn interests. This sense of dullness has overspread much of life, so that the atmosphere is charged with it and it is felt by the children. Consequently we find on Saturday mornings, even in summer,

<sup>1</sup> "The Language and Mental Development of Children," p 155

long queues of children making their way into the cinema instead of seeking adventure in the streets and lanes, or, better still, in the open green spaces. The problem of the child's leisure time is the problem of his interests. It is a matter of great concern to teachers.

Again, we must consider a child's interests when we are guiding him into a school course or into an occupation, for, from his likes and dislikes in school and from the occupations which satisfy him in his leisure hours, we can judge in what direction he will find most happiness as a man. The conception of education as a moulding process in which each child was shaped to the standard—so-called "ideal"—pattern has been finally rejected by the Education Act of 1944, and its place is being taken by a system which works, within the limits imposed by innate ability, through the emotions and interests.

This does not mean that we accept fully the conception that education is the process of stimulating the natural interests of the pupils; for we have learned that education depends upon other factors and that interests are rather acquired than innate, and so may be "learned". The general position is well expressed by the analogy noted by E. K. Strong, Jnr.<sup>1</sup> How fast each individual's boat can go is determined by the motor (abilities), but the rudder (interests) directs the way, and the distance travelled, measured in a straight line, indicates the length of the journey (achievement). The analogy brings home to us not only the importance of interests, but their general functions. If our citizens are to obtain enjoyment and satisfaction in life, the general direction in which they should go should be governed by what they need to do for self-fulfilment. It is obvious that one of the greatest responsibilities of teachers is to discover the goals at which their pupils are aiming; to encourage them to aim

<sup>1</sup> "Vocational Interests of Men and Women."

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at those which are healthy and to discourage those which are unhealthy. "Learning is the process of discovering a means of reaching a goal."<sup>1</sup> Unless the goal, the interest, is clear to the child, the educational process has no real value. "My experience is what I agree to attend to," writes James.<sup>2</sup> "Without selective interest, experience is an utter chaos. Interest alone gives accent and emphasis, light and shade, background and foreground—intelligible perspective, in a word."

### SUGGESTED CLASSIFICATION

For our purpose we use the term interest to include likes and dislikes, feelings of pleasantness or unpleasantness, wants or desires, appetites or aversions, satisfactions and dissatisfactions, and attitudes—that is, beliefs and disbeliefs. It is obvious that if we were to consider all the interests included in these terms we should cover a very wide field. For reasons of practicability, we shall have to confine ourselves to interests which are of special value to teachers.

There seems little need to record the child's interest in every school subject. It is probably more valuable to us to know the main types of his interests than to know the order in which he shows preference for the subjects of the curriculum. Nevertheless, teachers should make notes of any subjects which arouse in the child particular keenness or particular dislike.

It will be useful to record first his attitude towards activities which depend upon the exercise of the intellect, to reading, to study, to discussion, to school work in general, and to further education, because upon this interest will depend his general progress in school work.

<sup>1</sup> E. K. Strong, Jr.: "Vocational Interests of Men and Women," p. 6

<sup>2</sup> W. James: "The Principles of Psychology," Vol. I, p. 402.

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Many boys and a good proportion of girls will show scientific interests. This does not mean merely that they are interested in the performance of experiments in physics and chemistry, but that they like to make a systematic and logical approach to phenomena and ideas. They will be keen seekers after evidence and proofs, and will require to know the causes of all effects. As they grow older they will be more and more interested in the underlying principles of physical life. They will tend to gather up their experiences in generalizations.

Others will be more stirred by æsthetic interests. They will appreciate the beauty of colour, of line, and of form in art, of sound in music and in the spoken language, of rhythm and movement in dancing, of thought, feeling, sound and pattern in poetry. But it must not be imagined that this interest is confined to those who study the arts. The mathematician and the scientist may feel deeply the sense of order and of design in their work.

Many will show a deep-seated love of their fellow-men and the world in which they live. We shall find them reading biographies and geographical magazines. They will be keen students of current affairs and interested in civic and national affairs and government. But their interest will not be purely intellectual or scientific. They will be studying these things because they want to improve the world and better mankind. We have therefore called this interest Civic. If it goes so far as to include altruism and philanthropy, we might even describe it as humanistic.

Another interest which is strong in children is the desire to create. This interest gives children, especially when they are young, perhaps keener joy than any other. This is not confined merely to the making of things with the hands. The young child is proud of his drawing, his pieces of handwork, the two pieces of wood he has ham-

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mered together to make a boat, and the bulbs he has planted. But he is also interested in the new world he makes for himself when he grasps a new idea in arithmetic, when he can make a word from the sounds he has learned, when he can make a new word of his own to express his idea, when he can make a new sound that will startle those who hear, when he makes us laugh, and, sometimes, when he makes us cry. In other words, whenever he has changed his environment to fit his pattern then he feels this joy of creation. As he grows older he tends to give up the struggle against environment and far too often accepts the world in which he lives; but those in whom the interest is strong will find outlets for it in their craft-work, their written work, and in their ideas. They will paint pictures, compose music, write novels, plays, and verse, organize their fellows, and found families.

Most children have social interests. Some have a few friends only; others have many acquaintances and seem to have a great interest in conversation and in social gatherings of all kinds. They join youth groups, Scouts or Guides, debating clubs, drama groups, football, cricket, hockey and tennis clubs. They are keen members of their teams, houses and schools. This interest shows its highest form when the children find delight in working with others and in co-operating with them in enterprises. It may be merely the operating of the gregarious instinct, the seeking of society for a sense of security; but it may be much more, for it may be an endeavour to enable society to get the best results through a team spirit.

Physical interests are so much advertised today that to show little liking for games and athletics and sport generally is usually taken as a sign of ill-health or "wrong-headedness". There is often a danger that this interest may be over-indulged, with consequent neglect of others. It is good that a child should express himself as much as



is possible by a healthy interest in his body : but he must realize that his body is only a part of the whole being. We shall expect him to play games, to go for walks, to do P.T., to cycle, to swim ; but these are not the end-all.

Practical interests are to be encouraged in all schools. At one time there was a tendency to consider them the special province of modern schools and to neglect them in other types of school. Fortunately many schools now seek to encourage boys to take an interest in such practical subjects as gardening, housecraft (for boys and girls), handicraft of all kinds, and the making and using of simple tools, machines, and objects. Many schools find boys and girls delighted to help in a practical way in their dramatic productions as stage carpenters, electricians, costumiers, and stage-managers.

Finally one must not forget that many children have deep spiritual interests. In these materialistic days we often tend to overlook them. For young children, they are a simple matter centred in their fairy tales, myths, and Bible stories. But during adolescence they are, to many, a matter of very great concern and difficulty. At this period the growth of these spiritual interests should be watched very carefully.

It is not usual to attempt to comment on the undesirable interests of children, although they may be even more important than the study of those we have listed. Experience suggests that these matters should be handled very carefully, and it is often best to consult a psychologist when such an interest shows itself in repeated misdemeanours. We all like to forgive and forget the aberrations of children. Nevertheless they may be important indicators of maladjustment or of future lines of development, and for this purpose they should be recorded, but in the most confidential manner possible. It will necessitate careful individual study, for group work is inadvisable

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and almost impossible. Class discussions, especially on books and films, are very revealing, but most of the important information will be gleaned by the headmaster in his study. It is essential that the teacher should treat the matter objectively, in exactly the same manner as he treats measles. In the vast majority of cases the detrimental interest will disappear when the environment has been adjusted.

## MEASUREMENT OF INTERESTS

Although it is probable that it will be possible in the future to measure interests objectively by a group test in the same way that we measure general mental ability, for some time teachers will have to be content with their personal assessment. It is desirable, however, that teachers should experiment with the techniques that are used in attempts to measure interest. Accordingly, a number of experiments in interest measurement are described.

The quickest, simplest, but probably the least efficient way of measuring interest is to get the child to choose from a number of topics those which he likes the best and those which he likes the least. We suggested earlier, for instance, that it may be helpful to know the school subjects which make the most and the least appeal to the children. Merely to ask for the most liked subject is unsatisfactory. We should present the children with a list of all the subjects and ask them to pick out their favourites and least liked subjects or to arrange them in rank order. If all the subjects are to be ranked, the process should be completed in several stages, first picking out the best-liked three, then the least-liked three, and so on until all are included. A useful check is to repeat the test either exactly or in a different form. We may, for instance, make a list of concrete examples of the work involved in

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each subject; instead of Nature Study we can substitute a country walk, instead of algebra we can use solving equations, instead of geography we may take studying maps, and so on.

It is obvious that a list of situations or activities corresponding to the types of interest we have discussed may be dealt with in the same way. The children may be asked to arrange such a list as the following in order of preference; reading books about history, weighing materials in the laboratory, decorating a room with flowers, studying the conditions of people in other lands, writing plays, going to school parties, walking, operating machines, going to church. The answers will be revealing. The experiment can be made more reliable by using several activities, instead of a single situation, to represent each type of interest. This may necessitate arranging them in two or three lists, for the children cannot be expected to place in rank order more than about sixteen items. If the number of items is very large, it might be sufficient if the children are asked to indicate the position of each item on the following scale—like very much, like, indifferent, dislike, dislike very much—by marking with a pencil one of the five points: this method can be used only with older children. In America it is called the "Interest Inventory" method, and is much favoured for purposes of vocational guidance.<sup>1</sup> These methods may be used to find which parts of the syllabus make particular appeal to a class, and which are unpopular. It may be possible to get the class to give reasons for these preferences either in discussions or in written accounts. In this way the teacher may receive valuable guidance as to which topics and which methods arouse keenest interest.

<sup>1</sup> Rank's "Vocational Interest Blank" has 400 items (see Appendix to "Vocational Interests of Men and Women") and is scored differently to evaluate different interests.

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But it is not a completely reliable way of measuring interest. It demands the power of self-examination, and few of us are capable of measuring accurately our own reactions. Moreover children, and indeed all people, are often unconscious of their real interests. Furthermore, there is no measure of the relationship between the assessments of the children; one boy's interests may be so strong that his liking for the last item on the list may be greater than that of another boy for the item which he ranks first.

A more accurate method on similar lines is that of paired comparisons. In this method each subject or topic is compared with every other subject or topic, by taking the subjects in pairs and stating which one is preferred. A table is constructed as in Table 22.

TABLE 22

### *Method of Paired Comparisons*

	French	English.	Mathematics	Geography	Science.	Total	Order.
French	—	2	2	1	1	6	3
English	1	—	1	1	1	4	1
Mathematics	1	2	—	1	1	5	2
Geography	2	2	2	—	1	7	4
Science	2	2	2	2	—	8	5

The child compares French and English, and prefers English, so he places a 2 on the French line in the English column, and a 1 on the English line in the French column. As he prefers Mathematics to French, he places a 2 on the French line in the Mathematics column and a 1 on the Mathematics line in the French column. When the table

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is completed the lines (not the columns) are added, and the subject with the lowest score is the most preferred. In the example the subjects in order of preference are English, Mathematics, French, Geography, Science. The drawback to this method is that it takes some time if the number of items is large, while being only slightly more accurate than the previous method.

Another way of assessing interest in a narrower field is to present the child with a number of situations, arranged in groups, from each of which the child has to select the item which makes greatest appeal to him. This method has been used with considerable success when selecting children for different school streams at 13+. The selection for arts, science, commercial, and practical courses was to be made according to the vocation which was likely to be most suitable to the child. In order to do this, the children were asked to underline the occupation in each group of the following ten groups of four which most appealed to them. In each of the ten groups the child had to choose between occupations representative of the arts, science, commercial, and practical courses.

1	Historian.	Biologist.	Banker	Transport driver
2	Solicitor.	Chemist	Book keeper	Carpenter or joiner
3	Librarian.	Dentist	Insurance agent	Mechanic
4	Journalist.	Engineer	Telephone operator.	Painter or decorator
5	Interpreter (linguist)	Doctor (Nurse)	Estate agent.	Farmer or gardener
6	Teacher of English, or French or history	Teacher of science or domestic sub- jects	Comptometer operator.	Draughtsman.
7	Author.	Surveyor	Clerk.	Plumber
8	Architect.	Scientific research worker	Commercial secre- tary	Printer.
9	Publisher.	Dispenser.	Receptionist.	Shop assistant
10	Clergyman.	Health visitor.	Attendance officer	Policeman

The children were asked to work rapidly and to disregard considerations of salary and social prestige. The test was scored by giving one point to each occupation underlined in each column. The children were given, in addition, a list of occupations, asked to indicate their first three preferences, and to state their reasons for their

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choices.<sup>1</sup> When this information was considered in conjunction with their I.Q.'s, attainment scores, and records of dispositional qualities, it was possible to give reliable guidance to the boys and girls.

Questionnaires can be useful in measuring interests: their value lies in the fact that they deal with a variety of topics, and this makes them more reliable than a single subjective statement of attitude. "For instance, a boy may say that his attitude to education is highly favourable, yet when he is asked to endorse or reject a number of statements of different degrees of favour or disfavour and dealing with different topics—*e.g.*, the usefulness of education, its power in character-building, its influence for good or ill on the community, its purpose, schools, etc.—the result may show that his own opinion of his attitude is incorrect, for on some topics he may reveal an unfavourable attitude."<sup>2</sup> In the questionnaire the child's score is taken as the number of questions which he answers affirmatively.

The process has been made more accurate by building the questionnaire into an interest scale. "In order to do this, the statements have to be arranged on a scale in order from those expressing the most favourable attitude through a neutral zone to those expressing the most unfavourable attitude, and they have to be given a numerical equivalent. Instead of arbitrarily fixing the position of the statements on the scale himself, the investigator (teacher) asks a number of persons to sort them into eleven piles. By taking the average of these sortings

<sup>1</sup> It should be added that pamphlets dealing with the different occupations were supplied to the children, and talks, films and visits were arranged, to ensure that the children had opportunities of getting rid of any misconceptions that they might have about certain occupations.

<sup>2</sup> This and the next quotation and the Attitude Scale are taken from an article on "The Attitudes of Boys and Girls and their Parents to Education, Religion and Sport" by William Glassey, in *The British Journal of Educational Psychology*, June, 1945.

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it is assured that the result will be almost entirely free from personal bias. By recording these sortings and plotting them on a graph it is possible to determine the scale value of each statement, and to express it numerically, and, by noting the range of the scale over which the statements are spread by the sorters, it is possible to discover which statements are too ambiguous and to remove them from the scale." About thirty statements are selected which cover all points of the scale and which are approximately equal distances apart. The weakness of this method is that the scale consists of verbal expressions of opinion which may be misinterpreted, especially by children. The following scale for measuring attitudes towards education will serve as an example. The figures in brackets at the end of each statement indicate the scale-value of the statement.

### ATTITUDE TOWARDS EDUCATION

Name..... Age.... Years.... Months.... Form....

Below are a number of statements about Education. We want to know what you feel about this subject. Please read the statement carefully and then :

- (i) Put a tick (✓) if you fully agree with a statement :
- (ii) Put a cross (×) if you do not fully agree with a statement :

1. I am intensely interested in education. (1.0.)
2. I go to school only because I am compelled to do so. (10.0.)
3. I am interested in education but think that one ought not to get too concerned about it. (4.2.)
4. I like reading thrillers and playing games better than studying. (6.4.)
5. Education is of first-rate importance in the life of man. (0.5.)

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6. Sometimes I feel that education is necessary and sometimes I doubt it. (5.4.)
7. I should not do much work if I did not have to pass examinations. (6.9.)
8. Education tends to make people snobs. (8.4.)
9. I think time spent studying is wasted. (10.1.)
10. It is better for boys and girls to get jobs when they are fourteen than to continue at school. (7.9.)
11. It is doubtful whether education has improved the world or not. (5.7.)
12. I have no desire to have anything to do with education. (10.9.)
13. We cannot become good citizens unless we are educated. (1.3.)
14. More money should be spent on education. (2.2.)
15. I think my education will be of use to me after I leave school. (3.7.)
16. I always read newspaper articles on education. (3.0.)
17. Education does more harm than good. (9.8.)
18. I see no value in education. (11.4.)
19. Education enables us to live a less monotonous life. (3.3.)
20. I dislike education because it means that time has to be spent on homework. (7.4.)
21. I like the subjects taught in school but I do not like attending school. (4.5.)
22. Education is doing far more harm than good. (10.5.)
23. Lack of education is the source of all evil. (2.3.)
24. Education enables us to make the best possible use of our lives. (0.3.)
25. Only educated people can enjoy life to the full. (1.2.)
26. Education does far more good than harm. (2.7.)
27. I do not like school teachers so I somewhat dislike education. (7.1.)
28. Education is all right in moderation. (4.9.)



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29. It is enough that we should be taught to read, write, and do sums. (5·8.)
30. I do not care about education so long as I can live comfortably. (8·9.)
31. Education makes people forget God and despise Christianity. (9·9.)
32. Education is an excellent character builder. (1·8.)
33. Too much money is spent on education. (8·6.)
34. If anything, I must admit a slight dislike for education. (6·7.)

An individual's score is taken as the arithmetic mean of the scale-values of all the opinions he endorsed. This seems reasonable because there is the same number of statements that he may approve in each class-interval. The score of a group is represented by the mean of the scores of the individuals who compose the group.

The possible range of scores is 0·00 to 11·00. The lower the score the more favourable is the attitude. The following scale is used in interpreting the scores :

0·00 to 2·20.	Strongly favourable attitude.
2·21 to 4·40.	Moderately favourable attitude.
4·41 to 6·60.	Neutral attitude.
6·61 to 8·80.	Moderately opposed attitude.
8·81 to 11·00.	Strongly opposed attitude.

## ASSESSMENTS

For the purposes of the record the teacher should assess the strength of the interests on the five-point scale. To help him he may have evidence gathered from experiments on the lines indicated earlier, but usually he will have to rely entirely upon his observation of what a child does and says. In particular he should notice what a child observes—for we tend to observe what interests us—and the situations to which he shows aversion or dislike. In

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each type the breadth as well as the intensity of the interest should be considered. For example, a boy may be intensely interested in the Scouts, but be unsociable otherwise. A child whose interest is classed "A" will, in some cases, be so keen in that particular direction that it has a detrimental effect upon him, for he may show an excessive liking which leads to the neglect of other interests.

It is important to distinguish between natural and spontaneous interests arising from a desire for inward satisfaction and those aroused by ulterior motives. Children often declare an interest in a subject because they think that it is going to lead to a career or that it will be profitable to them. Such interests are often short-lived and usually shallow. Most people can quote instances of young men who have professed a liking for going to church or for playing tennis and who probably did think that they liked doing so; but later it has been observed that the interest in church-going and tennis-playing declined because the real centre of interest was some young woman. Some interests are really interests in social approval: many people, it is averred, cultivate bridge-playing for this reason: children will often interest themselves in matters which they believe will receive the teacher's approval. Sometimes declared interests are based upon insufficient knowledge and lack of experience, and therefore are misleading. The preference for black-coated jobs is a case in point; very often the child finds the job uncongenial, liking turns to disliking, and the child becomes an unhappy worker. It is important, therefore, when guiding a child, to attempt to distinguish the interests which have a temporary appeal from those which bring abiding joy because they spring from a sense of self-fulfilment.

It is not sufficient to indicate the position on the five-point scale, as this gives us no indication of the peculiar interests of the children. It requires a note of a more

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concrete character in some instances to supplement the information supplied by assessment under the general headings. For example, we may assess a child as "*B*" under the heading social interests. This does not give us such valuable information as the fact that the child is a keen member of the Scouts or Girl Guides, or has done some particular task in school which demands good community spirit. Similarly, "*D*" for social interests may need supplementing with the comment that the child avoids school functions, such as parties.

It is particularly important that these recordings should be made annually, for their significance lies partly in the development which can be noticed in them, both with regard to the interests of the individual child and of the group as a whole.

### CHANGES IN INTERESTS

One of the great difficulties in assessing children is the ephemeral nature of their interests; for a short time an activity becomes the chief centre of attention, and then it is almost entirely forgotten—the child "grows tired of it". The change may appear as a seasonal waxing and waning, as in playing with tops and marbles, or at football and cricket. But in many instances the interest dies out altogether. Most boys go through a period of life when they are interested in collecting stamps or catching butterflies or making fretwork models. For most of them these hobbies flare up, burn themselves out, and their place is taken by fresh interests. During adolescence changes are often very rapid. The sudden movement from one proposed occupation to another and from violent liking of one person, or subject, or style to complete apathy towards the same object frequently puzzles parents and teachers. On the other hand, some of the interests of our childhood remain throughout life. A boy who plays with

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his box of tools in infancy may still find much delight in woodwork and metalwork when well advanced in years : a girl who in infancy delights in music may still choose to spend her evenings listening to concertos and symphonies when she is a grandmother. Indeed, some of these interests—such as stamp-collecting—which appear as merely a phase in the lives of some people, engross others all their days. Although interests are changed frequently, it has been suggested that our strongest likings are of the same type throughout life—that is, that they all may be grouped as either physical or practical or æsthetic or intellectual, etc. Girls who are interested in dolls and in playing “house” become the women who are family conscious and house proud; boys who enjoy handwork and making plastic models become our craftsmen. Whether this theory is true or not remains to be proved, and teachers would do well to collect all the information they can on it, for such knowledge may well be valuable in vocational guidance. It is for this reason that it is well to record the favourite occupations of a child over a period of years.

Another problem which needs investigation is the difference in the interests of the sexes. It is probable that convention is wrong in several instances. It has been found, for example, that many boys are keenly interested in cookery and needlework, and are delighted when these subjects are introduced into the curriculum. Girls have responded well when given an opportunity to do handicrafts, such as fretwork and beaten-metal work.

### THE PERIODS OF LIFE WHEN INTERESTS DEVELOP

Some interests appear comparatively late in life. Nevertheless they may take permanent hold. Interest in religion, for example, usually appears at the time of

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adolescence. In childhood it is usually accepted without much display of feeling or excited thought. But in the period of adolescence it seems to become more and more important, until the time when there is a general falling away as the youth becomes more anxious about adapting himself to his material environment, as he becomes more concerned with his physical survival in the material world than with his spiritual existence. With some, however, religion remains the predominating interest; with others it is an important one. Christ's description of its distribution in the Parable of the Sower is apt.

The general tendency is for our interests to become more specialized as we grow older. In infancy we are interested in anything that has light, movement, or colour; in childhood we have many interests, and they range over a wide field. In youth, in the desire for mastery, more time is concentrated on one or two interests, and the rest are gradually allowed to sink into the background, to reappear occasionally at special seasons or festivals, or when they become topical.

In infancy, as we have seen, it is difficult to distinguish a child's special interests. Perhaps all we can do is to notice his attitudes towards other children, the teachers, and the school. In the Junior School we shall see developing his special interests in intellectual, social and creative directions, and we should note any other desirable interests. During the child's stay in the Secondary School, we shall probably be able to make assessments of all the interests we have mentioned.

### THE DESIRABILITY OF MANY INTERESTS

Following Herbart's plea for the development of many-sided interests, it is usually considered good to encourage a boy or girl to develop many interests. "Without falling into the error of assuming that children can or

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should be fashioned into some standardized pattern of balanced development," write Professors Oliver and Field,<sup>1</sup> "we are compelled to recognize that extreme lop-sidedness of development in young children at any rate, is educationally undesirable. The individual's mental health and the conditions of social life alike make certain demands on the development of interest and character which are unavoidable, and it is not safe entirely to neglect any important direction of interest or character development, no matter how well the particular short-coming may be compensated for in other directions. In children at any rate, any narrowly specialized development is not the best preparation for the complex demands of modern life. Thus the teacher should view with some concern the child who displays no interest whatever in some important side of the school life." While realizing the wisdom of this advice, we must not forget what has been achieved and won for mankind by those people who have had one sole interest and have devoted their lives to it. The wise teacher will know when to encourage a child to devote more time to particular interests and when to help him to widen his interests. He is more likely to be a sound judge of these matters if he has studied for a number of years the changes in interests of boys and girls.

It is good for a teacher to keep his own interests as wide as possible, for then he not only lives life to the full, but also is able to understand and sympathize with the great variety of delights of his children. A man who can show an interest in the games, dramatic activities, social meetings, and camp gatherings of his boys will have their confidence and can do much in that training for life which is so important a part of his job. A woman who joins her girls in their walks and outings, their hockey and netball, their interests in fashions and events, will similarly be

<sup>1</sup> "The Educational Guidance of the School Child," p. 49.

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able to guide them much better than if she confined herself to academic training alone.

### ✓CAN INTERESTS BE ACQUIRED?

In order to deal with these problems it would be well for us to find out to what extent interests can be developed, modified, or even changed. That they can be stimulated or discouraged by the environmental circumstances is assumed by most people. Most psychologists support this view, for they are of the opinion that interests appear only after the child has experienced his environment: they are formed as a result of his reactions to the persons and objects around him. Consequently Professor Strong declares, "They must all be learned. Accordingly they may be modified later on by re-education."<sup>1</sup> This opinion is reinforced by that of Professor Thorndike: "A person who has the ability to learn a certain science or art, but has been stopped from doing so by lack of interest, can probably acquire the interest if he wants to acquire it."<sup>2</sup> There is some evidence of the truth of these opinions in school and in life. We are all conscious of the changes in interests brought about by the war. For example, there was a much-greater and wider seeking for the pleasures given by the arts, especially music, than there was in pre-war days; for the arts nourished the spirit of men and women, and enabled them to relax from the tension of war. At the same time other men and women, debarred from the normal expression of most of their interests, became much more concerned with sex. In school we have many instances of classes which were lethargic under one teacher becoming lively and absorbed in their work under another. The teacher who endeavours to make every lesson an adventurous and joyful experience for

<sup>1</sup> E. K. Strong: "Vocational Interests of Men and Women," p. 10.

<sup>2</sup> E. L. Thorndike: "Adult Interests," p. 18.

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the children is likely to be much more successful in arousing interest than one whose lessons are dull explanations of textbooks. Even examinations, if treated in the right way, can evoke interest from children, for they set them a hill to climb; they are a challenge to their ability. They are only evil when they become an end in themselves, and when cramming for examination success supersedes the process of education. Similarly, when a boy has decided on the career which he is going to take up, he sees a purpose in much of his training and, although it often leads to a narrowing of interests—for example he may neglect everything except shorthand, typing and book-keeping, if he is going into an office—it does lead to his taking greater delight in the subjects concerned. From these examples, it seems safe to assume that interests can be brought to life or killed, that they “are caught by a sort of psychological infection rather than acquired through efficient instructions”.<sup>1</sup>

While this view is true in the main, it may have to be modified slightly in some instances. It does appear that some interests, such as our likings for different foods, are innate and that others are inherited. E. K. Strong notices,<sup>2</sup> “The evidence is fairly conclusive that occupational-interest patterns are well established in many children by fifteen years of age. . . . This means that such interest patterns are present before training and experience in the occupation could have caused them.” Only careful investigations can show whether these interests are inherited or moulded by the home or the social background. It appears that many interests are latent in children, and the good teachers will see that these are developed at the most suitable time.

<sup>1</sup> A. F. Watts: “The Language and Mental Development of Children,” p. 113.

<sup>2</sup> *Loc. cit.*, p. 12.



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Realizing the value which interest has in making for success, certain schools in America allow the children to choose the subjects which they will study. In England we try to guide them into appropriate "streams". At the same time teachers try to discover methods of arousing interest. The Dalton Plan, the Play Way, the Heuristic Method, the Project Method are techniques which have been developed for this purpose, and, when the methods have been suitable to the personality of the teacher using them, they have had remarkable success. Most teachers can give instances from their own experiences of a rapid improvement brought about by the development of interest. In this connection we believe that the ability of the teacher to make the lesson alive, to make it an experience, and to use such aids as good humour, is a most important contributory factor in the arousing of interest in a subject.

On the other hand, the teacher must tread warily. Nothing is so damaging as a pretended or forced interest. Children, like adults, may be led to admire people and things and ideas for the wrong reasons, particularly if it is fashionable to do so. There are far too many people of the "arty crafty" type who busy themselves insincerely about most human activities and lend their approval to false doctrines. A child's interest must be an honest sincere interest or it will be a superficial one.

Although interest alone cannot bring success—it needs general mental ability and special aptitude as bases on which to work—yet there can be no doubt of the power of interests. When wisely directed they are powerful aids to the teacher. It behoves us then to study them carefully. The school records enable us to keep account of our data from which we can draw our conclusions. Need we add that these conclusions should be set down in writing and then discussed with other teachers.

## CHAPTER VIII

# QUALITIES OF DISPOSITION

### METHODS OF INVESTIGATION

THE often-heard remarks that "it is character which counts" and "character is destiny" contain much truth. We all know the boy who, although he has marked innate ability, is nevertheless bottom of the class, the criminal who puts his cleverness to use in an anti-social fashion, and the young men or women who make sudden improvements or go downhill quickly, although they show no change in intellectual power, or in their special aptitudes. There are some who fall "victims of circumstance"; there are others who seem to rise above their environment to achieve uncommon success. We try to explain this difference between ability and performance by saying that the people concerned are of strong or weak character. But such an explanation is not precise enough for our purposes. If we are to forecast the future behaviour of our boys and girls, if we are to encourage strong character, and if we are to take measures which will enable the weak character to master his circumstances and to live as a better member of the community, then we must know clearly what are the factors which are found in a character of either sort, we must be able to recognize the distinguishing features of these factors, and we must be able to measure the strength with which they occur in the individual with whom we are concerned. This book does not offer full information on these topics; for there are vast fields of research to be brought to harvest before such knowledge is available and, as yet, some of the fields remain almost completely untouched by the plough.

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What we attempt to do in this chapter is to hand on to teachers such information as is available and to suggest lines along which they can experiment, in order that they can contribute to the necessary research on the subject. Indeed, in some aspects of the work, the gropings in the dark by teachers are probably the only means of supplying the data upon which advance can be made.

Investigation is proceeding along three main lines :

- (1) Observations made in interviews, especially during clinical examinations.
- (2) Test measurements.
- (3) Behaviour ratings.

(1)—The technique of interviewing cannot be mastered without much thought and experience. Most interviews are too haphazard and depend too much upon personal impressions. A good interview is carefully planned to set the child at ease, to cover definite points, and to give the interviewer an opportunity of observing the child's dominant motives. It is essential in most instances to make an indirect approach ; for example, by giving a child a puzzle to play with, we may learn more about his perseverance and self-confidence than we can from a more direct approach. Only occasionally will a teacher need to use a set interview, for he will have ample opportunity of observing the children's implicit ideals and standards of conduct in the daily life in the classroom and in casual conversations.

Cases of marked maladjustment and anxiety neurosis are not to be handled by the teacher, and should be referred at once to the medical psychologists appointed to deal with such matters. The teacher may help by noticing such cases early in their development and by referring them immediately to the specialist concerned. An outbreak of stammering or a loss of certain muscular controls should be watched by the teacher, but in this

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matter he should remember that a little knowledge may be misleading and may do harm. A child should not be sent to a psychologist or psychiatrist except after consultation with the headmaster and the parent. The better approach is to ask the psychologist to visit the school to observe the child in his normal surroundings.

But we must not rule out the findings of the clinics because they deal with special cases; there is no sharp dividing line between the normal and the abnormal, and the teacher in a school for handicapped children often picks up information which would be beneficial in the normal classroom. Moreover, what may be abnormal behaviour in one environment may be normal in another. An examination of the different standards of conduct set by different countries will furnish many illustrations of this. For instance, in New Guinea, native children of the Manus tribe are not expected to be obedient or to show deference to their parents' wishes.

(2) The tests used for the analysis of disposition are of a varied nature. A number of them attempt to indicate the presence or absence of a trait in the child by examining the "goals" at which he is aiming; others attempt to measure the strength and persistence of the trait; and others try to estimate the efficiency with which he directs his energy towards the goals he has set himself. There is not space to describe in details all the tests, but a list of those most frequently used is given.<sup>1</sup>

1. The child is asked to describe himself as he will be living at some time in the future.
2. He is given a list of (a) standard situations or (b) descriptions of persons and to each is appended

<sup>1</sup> Teachers who are interested in experimenting with these tests should consult Sir Cyril Burt's "Mental and Scholastic Tests" and his article on "The Assessment of Personality" in *The British Journal of Educational Psychology*, Nov., 1945.

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three or four possible reactions. He is asked to underline the reaction he prefers in each example.

3. Test 2 may be presented more indirectly by asking the child to write a story based upon an outline which is presented to him in such a way that he is encouraged to express his attitude towards certain types of people and his reaction to standard situations.
4. Free association tests, using standard lists of words.
5. Giving titles to pictures, and describing the pictures.
6. Ranking pictures in order of preference.
7. The Rorschach blot tests in which he is required to underline the interpretation he prefers.
8. Ranking persons and actions according to moral approval or disapproval.
9. The "Will-temperament tests" of June Downey for measuring persistence and self-confidence.
10. Questionnaires.
11. Scales built to measure certain qualities of disposition.

Most of these tests depend to some extent upon the personal impressions of the tester. Perhaps the most useful to the teacher are the two last mentioned. Accordingly, we deal with them in greater detail.

The technique of questionnaires is now familiar by reason of the use of them in "Gallup polls" and "mass observation". But the field of their use is limited. They are very good as a means of collecting evidence of opinions, particularly when the issues are clear cut, but as yet they are incapable of measuring accurately, especially such intangible qualities as sociability. They may be adapted, however, in various ways to furnish useful information about dispositions. One method is to ask questions about a number of situations, incidents, persons, or objects, to try to indicate the presence or absence of a particular quality in an individual. If we wished to know about

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the sociability of a person, for example, we could ask such questions as the following :

“ Do you prefer to go walks on your own or with other people? ”

“ Do you go to parties whenever you are asked, sometimes, or never? ”

The questions should be as indirect as possible and the test should be taken as a speed test. A rough measurement of the strength of the trait in the individual is attempted by adding up all the questions which are answered positively and counting this as the score.

Objective tests for measuring character are still in their infancy, but a good deal of work is being done on them, in America especially. Cattell<sup>1</sup> suggests that once the problem of what traits are to be measured is settled, it will not be long before objective means of measuring them are found. A fairly accurate assessment could be made by using scales built in the manner of the scales of attitude described in the chapter on interests (see p. 158). One objection to such tests is the time involved in their application. There would have to be a scale for each factor, and to apply and score them all would take many hours.

(3) In behaviour assessments the assessor is required to rate the child's possession or lack of a quality from his observations of the child's behaviour. The drawbacks to this method are obvious. Personal bias may influence the judgment. But at the moment this technique is the simplest and easiest for teachers to apply. It has a great advantage in so far as it requires that the teacher should study the children of his class very carefully throughout the time they are in his care. Test methods are more objective, but do not require this personal interest on the part of the teacher. Moreover, the teacher can incor-

<sup>1</sup> “ The Description and Measurement of Personality.”

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porate in his assessment the results of any tests and the observations made in any interview. In consequence, although other measures are more objective, we suggest that this part of the record should be filled in with behaviour assessments. But we would suggest that many teachers should experiment with other measures along the lines here indicated.

### WHAT WE ARE ASSESSING

The second and perhaps greater problem is to decide what we mean by disposition. On school record cards and booklets we find various terms used for the heading of this section—character, temperament, personality are three of the chief—and under these main headings appear a very large number of the abstract virtues and vices. Cattell has tried to analyse these, and to reduce them to an all-embracing twelve factors. Unfortunately, his book<sup>1</sup> contains so many technical terms and newly-coined words that it is very difficult to read. Moreover, it makes assumptions that psychologists of the calibre of Professor Godfrey Thomson cannot accept.<sup>2</sup>

In this confusion it would be well to define some of the terms we use before we go further.

There is a tendency for each individual to behave in a way peculiar to himself, when faced with a certain circumstantial environment or when subjected to certain stimuli. We say that the person is disposed to act in this way, and the combination of factors in his make-up which produces this reaction we call "disposition". It is not a single factor, but is produced by the action of several forces, notably instinctive reactions,<sup>3</sup> temperamental moods,

<sup>1</sup> "The Description and Measurement of Personality."

<sup>2</sup> See Professor Thomson's review of the book in *The British Journal of Educational Psychology*, XVII, p. 118.

<sup>3</sup> Some psychologists deny the existence of instincts as such but admit the influence on man's behaviour of elemental drives. For ease in explanations we shall refer to them as instincts.

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intellectual predilections, and moral forces. Let us consider these forces in turn.

An instinct is an innate method of behaviour which is common to all members of a species of the same sex and age: it is independent of learning. The excitement of an instinct gives an impulse to put forth physical energy in an endeavour to reach the goal of the instinct. The peculiar quality of this general physical and mental excitement in a human being we call an emotion. It is possible, therefore, to define an instinct by the nature of its goal, to judge its force in a person by the power of its physical reaction, and to describe its quality by reference to the emotional disturbance it causes. Accordingly, the drive, which in mammals leads to the care of the young during the growing period, we refer to as the parental instinct; we can measure its force by the actions which the animal takes to protect its babies, and may note how this force decreases as the young mature, for they are left more and more to protect themselves; the quality of the instinct is judged by the tenderness of the parent to the young. By using this method of defining instincts, McDougall classified them and their attendant emotions as follows:

Instinct	Emotion.
1. Escape from danger . . . . .	Fear
2. Combat . . . . .	Anger
3. Repugnance . . . . .	Disgust
4. Parental, protection of young . . . . .	Parental feeling
5. Curiosity . . . . .	Adventure
6. Self-assertion } . . . . .	Superiority
7. Self-abasement } . . . . .	Subjection
8. Cry of distress . . . . .	Helplessness
9. Sex . . . . .	Sexual desire
10. Herd (gregarious) . . . . .	Loneliness
11. Food seeking . . . . .	Appetite
12. Hoarding (acquisitive) . . . . .	Feeling of ownership
13. Construction . . . . .	Feeling of creativeness
14. Laughter . . . . .	Amusement



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Often when we examine behaviour, we find several of these instincts functioning together. Sorrow for the loss of a loved one may proceed from sex, parental, herd, and the escape from danger instincts operating together. The drive produced from such an emotion (an emotional drive) may vary in force from individual to individual, and it is modified in the same person at different periods of his life. The emotional force of sex, for example, increases greatly in adolescence and gradually dies in old age; the rise and fall in the strength of the emotional state of fear, to take another example, can be easily observed.

A man's temperament is the sum of the effects upon his mental life of the metabolic (chemical and physical) changes that are continually going on in all the tissues of his body. By reason of these metabolic changes his feeling-tone is constantly changing. We are all conscious of these differences: we know the days when we are feeling on top of our work, and the days when we are feeling oppressed by it, and yet we can give no conscious explanation of why this should be so. The symptom which is familiarly described as "having got out of the bed on the wrong side" is another example of the functioning of temperament. In some people the changes are more sudden and more violent than in others, and in consequence they are usually described as being "temperamental". Most people, however, are more stable in temperament, and may be characterized by their prevailing feeling-tone as cheerful or gloomy, optimistic or pessimistic, volatile or lethargic.

The behaviour of an individual is modified, too, by his innate intelligence. As we have seen (see Chapter IV), although it is popularly believed that general mental ability can be increased by sending a child to a good school, or by a good teacher, research seems to indicate that we cannot increase it in any individual. This is

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important, because our reactions to our environments, both external and internal, are controlled to some extent by our general mental ability. The greater the I.Q. of a child, the greater is his power to foresee events and, consequently, the greater is his opportunity to alter his action to meet those events. A tactful man can judge what the results of his actions will be and, in order to make himself more sociable, he modifies the expression of his dispositional qualities to make them more acceptable to other people. Often, however, the judgment of a man is clouded by the functioning of other more powerful qualities, and so, although his "intelligence" may be well above average, he may behave foolishly. The tendency is for the child, as he grows older, to attempt to control his behaviour. Often we shall have to look well below the surface to find the real person, for, even when quite young, children learn to hide their natural reactions beneath a more conventional behaviour which experience has taught them is required of them. This attempt at control by the intellect may produce emotional conflicts which are very disturbing, and which need careful treatment.

Before considering moral forces, it would be well to deal with personality. If a child is to grow up with a harmoniously developed personality, he must either adjust himself—or be adjusted—to his environment or else he must adjust the environment to his own mental make-up. Each person will make this adjustment in his own way according to his "personality". The adjustment will depend upon the bodily health of the individual, including his resistance to disease, his endocrine system, the efficiency of his nervous system, and hereditary units (genes). It will be modified by his temperament, which will enable him on some occasions to adjust himself, but which on others will make him to appear at odds with the world.

Again, as we have seen in the previous paragraph, it will be considerably influenced by the innate mental capacity of the person. Summing up, we may say that by personality we mean the sum of the characteristic reactions of a man to his external and internal environment, depending upon his physique, his temperament, and his intelligence. We must add one more point. Personality is not governed by any moral considerations; it is amoral. Indeed, both moral and immoral persons may have well-defined, strong personalities.

When moral force is taken into consideration, we are dealing with a person's character rather than his personality. We can hardly say that Falstaff has a good character—for he seems completely amoral; but his personality makes him one of the most popular of Shakespeare's personages. Another instance may make the distinction clearer. An illness, such as that caused by a duodenal ulcer, will produce a change in personality quite quickly because it renders a man less capable of dealing with his environment, but it will not alter his character, until it has broken the moral force which stabilizes the sentiments.

In attempting to explain what we understand by qualities of disposition, we have perhaps over-simplified the psychological interpretations of the terms used and attempted to be too clear-cut in our distinctions. We would, therefore, emphasize that in a human being's behaviour all these factors are intricately interwoven. We shall often be able to see the influence of one of them modifying an action, but more frequently it will be impossible to say which factor is the spring of a certain aspect of behaviour, because it will be impossible to isolate it. In considering the behaviour of children, therefore, we endeavour to assess the strength or weakness of their dispositional qualities, which as we saw earlier

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in the chapter are formed by the fusing of these forces.

Many psychologists have attempted to distinguish these dispositional qualities. Cattell<sup>1</sup> suggests that, as soon as we begin to develop in childhood, the environment plays on our basic or source traits (that is innate drives or instincts), and we begin to exhibit behaviour, caused by the modification and the combination of these source traits, which produces qualities of disposition which he calls "surface traits". Cattell gives a list of what he considers to be source and what surface traits, but the list is in general so technical that, without considerable psychological training, teachers would be unable to use it. There is need for considerable research to find out what the essential traits are, and to name them on a scientific but easily understood basis. We confine ourselves in this chapter to those qualities which usually appear on record cards and booklets: perseverance, sociability, conscientiousness, willingness to assume responsibility or leadership, stability, co-operation, self-confidence. Other qualities are sometimes listed, but they are to be avoided at this stage in the development of school records, either because they are so complex in meaning that no adequate psychological analysis is available or because they are simply the names of abstract qualities without any psychological significance.

## ASSESSMENT

The teacher is constantly measuring these qualities of disposition. He tells another teacher that his class is not so hard-working or pleasant to handle as the one he had in the previous year, or he reports to the parent that Robert's work shows some improvement, but he could

<sup>1</sup> "The Description and Measurement of Personality."

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do better. He informs the headmaster that John does not mix with his fellows, and that Eric is lacking in self-confidence. Often he attempts a quantitative assessment for the purposes of awarding stars or house points. For the purpose of the record these assessments are too vague; we require a more precise estimate. Two ways of making them more valuable are the ranking method and the rating method.

In the ranking method all the children in a class are arranged in rank order from the highest to the lowest, or from the best to the worst, with regard to the specific quality being considered. A good deal of the success of this method depends upon the teacher having a clear conception of what is understood by the quality being considered. For this purpose we have attempted to describe some of the chief symptoms of some traits later in the chapter. Most teachers are familiar with the ranking method, for it is often used when marking hand-writing, drawing, or essays. For purposes of recording, the children can be arranged on the five-point scale according to the normal distribution: that is  $A = 5$  per cent,  $B =$  next 25 per cent, etc. (see p. 36). The teacher should bear in mind, however, that the class is not likely to be a "random sample"; it has probably been selected to meet some need of the organization of the school, and therefore the distribution may be skewed. The method takes considerable time if the class is a large one, although it can be much speeded up by having the names of the children on slips of paper or card which can easily be moved from position to position. The teacher will find the exercise valuable, however, since it encourages him to think more precisely about disposition, leads him to be more careful, accurate, and objective in expressing his opinions, and, above all, requires him to study the behaviour of his children in detail and scientifically.

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The teacher who has ranked his class for a number of qualities of disposition will know a good deal about them. But he will not know everything. Children's behaviour in school may be very different from what it is out of school. Often we are puzzled by the worried parent who "cannot do anything with Johnny", for we know Johnny to be one of our most helpful and best-mannered pupils. In an attempt to get an assessment on a wider basis, some teachers ask each child to place in order the first five in the class for a particular quality. For every first place he is awarded by his fellows, a child scores five points, for a second four points, and so on, and the child's rank depends upon the number of points he scores. The method is open to much criticism, but it may lead to the revelation of some useful information, and it does lead children to a consideration of what is worthy in disposition.

When we use the rating method, instead of comparing the child with the others in the class, we attempt to compare him with all other children of the same age and sex, by assigning him to one of the classes on the five point scale. The great weaknesses of this system are that a teacher's judgment is limited by his experience of boys and girls, and so one teacher's assessments may not be comparable with those of another teacher, and that some essential aspect of the child's behaviour may be overlooked so that the assessment is only partially true. To minimize these errors, the points on the scale for each quality should be defined as clearly, completely, and concretely as possible. If a description of the quality and a list of typical situations that should be borne in mind are given in addition, the assessments are likely to be even more efficient. Tentative scales are suggested later in the chapter.

When rating, the teacher should remember not only the normal distribution which suggests that 5 per cent,

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or 1 in 20, of an unselected population should be classified as "A" in each quality, but also a number of other considerations. "A" usually means that the quality is possessed to an excessive extent, so that the child's disposition as a whole is unbalanced and the behaviour of a child so classified may not be the best behaviour: when leadership shows dictatorial qualities it is no longer admirable. Again "A" in one quality may be incompatible with "A" in another quality; the child marked "A" for leadership is not likely to be "A" for sociability, and the child marked "A" for sociability is not likely to be "A" for conscientiousness or for self-confidence.

There will be a tendency for the teacher's assessments of some qualities to deviate from the normal curve, for what they are assessing may consist of more than one variable (it has been suggested earlier that the qualities of disposition are formed by the interweaving of some or all of the factors mentioned at the beginning of the chapter). In those which involve moral or social forces there is a tendency for the majority of the assessments to be nearer the "A" end of the distribution than the "E" extreme—that is, the curve is skewed negatively. If these qualities were elemental, then their distribution would follow the normal curve; but if each consists of two or more elements, then, unless the elements are highly correlated in their inherent strengths, the resulting curve of distribution will not be normal. The results of the attempts of teachers to assess 3231 children between the ages of 10 and 11 are given in Table 23. These figures reveal the tendencies of the distributions to be skewed by social and moral qualities. It may be possible from data collected in future years to clarify the position.

Assessments should be made as objectively as possible. Personal opinions or attitudes should not be allowed to

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## TABLE 23

*The Assessment of Qualities of Disposition for 3231 children of 10 to 11 years of age in 1946*

Quality.	Assessment.					Percentage deviation from normal distribution.					Mean per cent deviation	Reliability order.
	A.	B.	C.	D.	E.	A.	B.	C.	D.	E.		
Initiative . . .	140	702	1622	705	162	- 11	12	+ 17	13	- 1	11	1
Self-confidence . . .	180	859	1161	619	112	+ 10	+ 5	+ 12	- 20	- 31	16	2
Leadership . . .	105	677	1573	749	189	- 36	- 17	+ 17	- 8	+ 16	19	3
Perseverance . . .	324	907	1291	496	121	+ 100	+ 12	1	- 39	- 26	36	4
Sociability . . .	251	1114	1345	428	54	+ 54	+ 37	+ 6	- 47	- 70	43	5
Co-operation . . .	373	1059	1255	457	71	+ 129	+ 11	- 4	- 44	- 55	49	6
Conscientiousness . . .	397	873	1322	524	135	+ 140	+ 7	1	35	- 17	56	7
Normal distribution of cases	163	815	1304	415	163							
Mean of all actual distributions	253	845	1105	569	122	+ 55	+ 6	+ 7	- 29	- 26		
Mean deviation of all actual distributions	36	100		103	37							
Per cent deviation of all actual distributions ( $\frac{M.D.}{M.} \times 100$ )	34	11	6	14	29							
Per cent error from normal distribution	55	9	7	30	25							

interfere. There is a danger of considering the qualities of disposition from a moral point of view, and of modifying our grouping by considering "A" to be more desirable than "B", and "B" better than "C", and so forth. If, for example, we take extraversion-introversion as our continuum in the scale for "general temperament", we should remember that the best-behaved character will appear at "C", and that both extravertly and introvertly unbalanced characters have much to contribute to the life of the community. At this point we are more concerned with recording the characteristics of our children, in order to help them to adjust themselves to their environments, than with getting them into the Kingdom of Heaven, although this must remain our ultimate object.



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Whenever possible it is beneficial to use the assessments of several teachers to arrive at the assessment which is recorded; for children react differently to different teachers, and each teacher has peculiar opportunities of observing the children—hence arise many of the difficulties that occur when individual children are discussed at staff meetings. The pooling of assessments will confirm the teacher's original assessment or indicate where further investigation is necessary. But all assessments should be made independently, without knowledge of the assessments made by other teachers. As in ranking orders, the use of the ratings of other children may produce significant evidence; but such ratings must be used with great caution.

It is a good plan to deal with one quality at a time, using named slips to distribute the children into the five groups. Boys and girls should be distributed separately, since the distribution of boys and girls together may produce a bimodal curve, and one age-group should be dealt with at a time. If we attempt to deal with all qualities for one pupil at the same time, there is danger that the assessment of one quality may colour the assessments of the others. Sir Cyril Burt has warned us against the "halo" effect, which assumes that a child that is "A" in one subject or quality must be "A" in all.<sup>1</sup> It might be well in exceptional cases to make the assessments of a specially interesting child in all subjects at the same time, by using the method of paired-comparisons described in Chapter VII (p. 155).

Again, we must bear in mind that our assessments will be governed to some extent by our own abilities and dispositions. All teachers should be familiar with their own I.Q.'s, for then they would realize that they are not representative of the average human being; most teachers

<sup>1</sup> *The British Journal of Educational Psychology*, Vol. XV, p. 85.

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have an I.Q. which is more than ten points above the mean—that is, on the average they are in the first third of the population. If we are not careful we shall use ourselves as the standard, and we shall regard too many of our own children as subnormal. The same argument holds in dispositional assessments and, therefore, the teacher should find out as much as he can about his own disposition by asking his friends and colleagues to judge him on the five-point scale.

When making assessments, teachers should not rely upon general personal impressions, but should base their grading upon observations of the children's actions and words recorded over a period of some time. The teacher should, for his own use, supplement the record card or booklet with a notebook. He should, in addition, be familiar with the more important and more easily observable symptoms of the qualities. Moreover, just as the assessments are more reliable if they are the work of several assessors, so they are more reliable if they are the average of several observations, for they tend to be more objective estimates.

The cry will be raised that this will take much time. The answer is that the work is important. To take one argument only, if the record card is to take the place of certain important examinations, a child's future may depend upon it. Consequently it will be worthy of much attention and interest, worthy of an amount of time at least equal to that now spent on examinations. Again, the entering of the data on the records need not be burdensome, if it is spread over a period of time. Moreover, boys and girls are fundamentally interesting to teachers and, as they study the problems involved and record their observations, teachers will find the job enthralling. But this does not mean that headteachers should not arrange to make the task as easy as possible by allowing time for

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the job, by making the number of assessments to be made by any one teacher as few as are necessary, and by using the cards when completed, instead of locking them away as so much useless data collected for the gratification of administrators, inspectors, and Parliamentary questioners.

### THE QUALITIES ANALYSED

Sir Cyril Burt has laid down that "each trait should be explicitly and unambiguously defined, and the different grades of it illustrated by brief concrete descriptions".<sup>1</sup> The following descriptions and five-point gradings are offered as suggestions for the consideration of teachers. They should be regarded as a basis for experiments.

#### *Perseverance*

Perseverance depends upon determination, the courage to face difficulties, the stamina to carry on despite the difficulties, and the power of concentration to resist distractions. The persevering child sees a job through to the end and follows an argument to its conclusion. He is not easily turned aside from his purpose, which is probably based upon some personal ideal or some social or moral force. His colleague, without this ability, gives way at the first obstacle, defers readily to the opinions of others, or is easily turned aside from his purpose by some attraction of the moment. He is constantly changing his jobs, his opinions, and his ideals. He sometimes seems feckless and will-less. When assessing this quality, we shall have to consider the abilities of the boy concerned: a boy with a high I.Q. will not show this quality so obviously as one with a low mental ability.

<sup>1</sup> *The British Journal of Educational Psychology*, Vol. XV, p. 85.

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A.	B	C	D.	E.
lenacious persevering to the point of obstinacy never admits defeat often single minded	Persistent in spite of real difficulties not easily discouraged.	Works attentively until real difficulty is met Can resist minor distractions	Can overcome some difficulties if given an incentive to do so. Can concentrate for short periods easily discouraged	Gives up upon encountering any difficulty. Very inattentive.

### *Sociability*

The sociable child enjoys being with other children and people, not in order to co-operate in a joint activity, but for the simple pleasure of being with them. Consequently he makes many friends with whom he mixes easily. He talks freely and naturally to people, even strangers, and is ready to arrange for their comfort, to supply their needs, and to put them at their ease. Usually he is cheerful and smiling, and quite amenable to discipline; for he realizes that it is the law of the herd. Scout meetings and societies of all kinds attract him. Often he will arrange his own little groups for special activities. His opposite is anti-social, shy, unpopular, often solitary, defiant of authority, afraid to meet strangers, self-seeking, sometimes aggressive, selfish, jealous, envious, and suspicious. He does not co-operate easily in team activities: his few companions are usually undesirable and are frequently changed; and he is often the cause of mischief-making between people. In adolescence he finds it very difficult to meet members of the opposite sex.

A	B	C	D	E
Is really happy only when with others, seeks social activities continuously. Is very popular.	Enjoys company at all times and often seeks social activities Is popular	Generally enjoys being in society but occasionally withdraws Has many friends but is unpopular with some people.	Avoids groups of people and strangers but friendly towards a few acquaintances.	Anti social in attitude prefers to be alone unfriendly egotistical

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### *Conscientiousness*

The conscientious child is anxious to do what is right, and usually has a standard of behaviour in mind to which he attempts to conform. This pattern of behaviour will change as the child grows older, so that conscientiousness in children will display itself in different ways as the child's sense of values matures. Consequently the age of the child should be remembered when an assessment is being made. A conscientious child has a keen sense of duty, will keep the law when not supervised, is scrupulously honest (the "romances" of very young children must not be considered as lies), idealistic, frank and open. He usually works hard and "plays the game". Sometimes the moral force is so strong that the child will not spare himself in his efforts, so that he may overwork himself. When this power is not operating in a child there is a tendency for work to be hurried and neglected, for superficial attitudes to be taken up, for details to be overlooked, cheating and other dishonest practices are common, school and team loyalties are broken, and the child cannot be relied upon.

A	B	C	D	E
Keen sense of duty reliable great pride in work will not spare himself in order to be loyal to others careful attention to detail.	Careful pride in work at tentive to details	Generally can be relied upon but sometimes fails	Little sense of duty careless about work neglects most details	No sense of responsibility no sense of loyalty or duty neglects all details dishonest.

### *Leadership*

The boundaries between leadership and initiative are not clearly marked, and therefore no attempt has been made to distinguish them. They are, to a great extent,

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synonymous. A leader cannot lead without initiative · a man who has initiative displays it by leading.

It is generally considered that leaders are "born". They are people who want to change their environment, and usually that of their fellows, and who have the power of attracting followers and persuading them to follow the path they have mapped out. Usually they are assertive and sometimes dictatorial—although this may imply some diminution in the power, if the dictates have to be enforced. Usually they have initiative and resource. They become leaders in P. I. lessons, captains of teams, founders of gangs. They will be anxious to "get up" plays, to run societies, and to arrange meetings. The tone of the class will be set by them. People deficient in the quality are easily led, conventional in their outlook and ideas, dependent on others or upon instructions, too submissive in attitude, and without initiative.

A	B	C	D	E
Anxious to make others follow him and has power to do so may dominate or become dictatorial never yields will stand alone against great odds His original ideas	His ideas and attempt to persuade others to accept them may succeed with small groups Often has a social conscience capable of standing on own often times the lead will take it if required he is useful in difficulties	Will occasionally go own way but not if it involves much effort usually happier when being conventional if fellowing lead of another but capable of taking initiative	Follows others rather than make any effort to go own way few unconventional ideas likes to have instructions	Servile submissive conventional completely lacking in ideas and initiative never attempts to influence others learns upon others

### *Stability*

It will be rare that a child who is otherwise normal will be found to be completely stable, for it is one of the characteristics of childhood that attitudes are being constantly changed in order to meet new circumstances in the

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environment. We shall find, however, that many children are cheerful, placid, unexcitable, contented when faced with normal situations. They may occasionally, when disturbed by illness, by emotional conflicts arising from their home circumstances or by a change of class or teacher, show some signs of instability. The moods of some children, on the other hand, are constantly changing: they are irritable; their emotions are quickly fired; they are changeable, fickle, mercurial, often self-contradictory, peevish, and at times destructive. They cannot be depended upon.

A.	B.	C.	D.	E.
Mood constant: unexcitable: stolid: insensitive.	Unexcitable except by strong stimulus: general mood rarely changed.	Calm and contented in familiar circumstances but disturbed by strange environment.	Excitable: changeable in mood.	Fickle: highly excitable: very moody: liable to panic.

### *Co-operation*

Co-operation is marked by a desire and willingness to help, which probably has its foundation in a sense of social values—in some cases perhaps moral values. It must be distinguished from sociability. A child who becomes friendly with another for the pleasure that is to be derived from companionship is being sociable; a child who becomes friendly from a desire to help another person or to work together for some purpose is co-operative. Perhaps the dominating feeling is one of sympathy. In some cases it will go as far as extreme self-denial and attempting to co-operate with children who show themselves to be hostile. The unco-operative children are self-centred, and deficient in the "herd instinct". They are individualists and wish to go their own way. At times they will be aggressive, and may become bullies. Often they are

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critical of the work of others, and in many cases their tone is sarcastic.

A.	B	C	D	L.
Very eager to help sometimes with indiscriminating eagerness.	Enjoys being a member of a team or helping others often seeks opportunities to do so	Usually co-operates when called upon to do so	Needs encouraging to co-operate with others selfish outlook, so that many co-operate for own ends	Shows antagonism continuously to others' wishes, ideas, and activities highly engrossed in self.

### *Self-confidence*

Self-confidence is revealed by the child's reaction to his environment. The child is confident that he can deal with the situation in which he finds himself or meet the person to whom he is introduced. In some cases it may amount to a sense of superiority. He is not embarrassed or shy, and will behave naturally and speak freely, without hesitating and without stuttering. He will be capable of standing alone in a game or in an argument, will play a part in a play or sing on his own without being nervous. If he lacks this quality he will be inclined to shyness and timidity, will avoid strangers, and hesitate in approaching people whom he knows really well, such as his teacher and headteacher. A stranger, such as the doctor, will probably render him speechless, and may even cause interference with his rate of breathing. He will be over-conscious of his deficiencies of stature, of speech, of ability, and of any peculiarities of home circumstances, such as poverty or the marital difficulties of his parents. This sense of inferiority may grow into a dominating sense of shame and later may even become despair. A child in such a condition will be anxious, tense, lacking in inner harmony. Rarely will he do the things that he would like to do.



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A	B	C	D	E
Self-assured so that it may become restless or cocksure often not willing to accept advice	Confident of own abilities self-reliant	Usually confident in familiar circumstances	Inimid lacking in confidence easily embarrassed	Very diffident avoids responsibilities has sense of shame and inferiority

The results of all assessments should be recorded in a form similar to that in Table 24. Boys and girls should be recorded separately.

TABLE 24

## Summary of Assessments of Qualities of Disposition

		Ave	A	B	C	D	E
1	Perseverance	7 to 8 8 to 9 9 to 10 10 to 11					
2	Sociability	7 to 8 8 to 9 9 to 10 10 to 11					
3	Conscientiousness	7 to 8 8 to 9 9 to 10 10 to 11					
4	Leadership	7 to 8 8 to 9 9 to 10 10 to 11					
5	Stability	7 to 8 8 to 9 9 to 10 10 to 11					
6	Cooperation	7 to 8 8 to 9 9 to 10 10 to 11					
7	Self-confidence	7 to 8 8 to 9 9 to 10 10 to 11					

From this form the headteacher can see quickly the distribution of the assessments of his teachers. If a copy is forwarded to the local authority, statistics for the

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population of the whole area can be computed and the reliability of the assessments calculated. If the curve of such a large number of assessments differs from the normal curve, then it suggests that an investigation should be made to discover the possible causes.

### A BI-POLAR FACTOR

In his examination of emotional traits,<sup>1</sup> Sir Cyril Burt discovered :

- (a) A general factor, "emotionality".
- (b) Two or more bi-polar factors, namely
  - (i) a tendency towards introversion and its opposite;
  - (ii) cheerfulness and its opposite;
  - (iii) possibly a responsiveness to persons and its opposite.
- (c) A number of specific factors, corresponding to some extent with McDougall's catalogue of human instincts.

It is obvious that the teacher is rarely able to go into such detailed analysis of the emotional qualities of his children, but Sir Cyril Burt's analysis suggests that it is possible to make an assessment of general disposition on a five-point scale, if we use Jung's classification of people into two types, the introverts and the extraverts, and if we give these terms a somewhat wider interpretation than Burt does, so that they include all three of the bi-polar factors listed above. At the "E" extreme of the scale are people who are highly introverted, at the "A" extreme people who are highly extraverted, at "C" the people who are well-balanced between the two. This scale will form a much better basis for assessment than the scale labelled

<sup>1</sup> "The Assessment of Personality" in *The British Journal of Educational Psychology*, Nov., 1945.

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“general attitude” or “general temperament” on most record cards.

It would be well, therefore, to attempt some clarification of these terms. Introverts, as the word suggests, are turned inwards upon themselves. “The introvert creates his world within, and is a thinker, perchance a mere dreamer.”<sup>1</sup> They are concerned with themselves and out of touch with physical reality. In consequence, they often imagine themselves to be in the wrong environment and, to a superficial glance, this would seem true. But a closer examination shows that phantasies derived from the sub-conscious are to them the real environment. Their whole outlook is subjective; things are seen from their own personal angle. They tend to withdraw into themselves, to shun society as a whole, relying on one or two friends; they are shy, sensitive to public gaze or notice, abstracted in demeanour, not communicative, inclined to worry, and often suspicious. They shun social gatherings, and often find delight in lonely walks and lonely hobbies. Their dress is usually unobtrusive. Often they are not without ambition, but their continual self-conflict prevents them from expressing their desires in overt action. When they do act, they usually fail to do what they wish to accomplish. If an introvert's I.Q. is high, he may well show signs of developing into a first-class scholar, but, if it is low, he will tend to be very backward and inclined to such habits as masturbation, with consequent mental trouble due to a feeling of guilt.

The following list of tendencies pointing to introversion, founded on Jung's work, may be useful to the teacher.

### INTROVERTS

1. Few acquaintances.
2. Feelings easily hurt.

<sup>1</sup> G. H. Thomson : “Instinct, Intelligence and Character,” p. 229.

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3. Suspicious of motives.
4. Stays in background on social occasions.
5. Prefers to work alone.
6. Easily embarrassed.
7. Avoids public speaking.
8. Worries over what may happen.
9. Day dreams.
10. Absent-minded.
11. Becomes easily absorbed.
12. Slow in decisions.
13. Interested in thoughts rather than in people.

The word extravert is again an indication of the trend of the disposition. An extravert's thinking, feeling, action are directed out of himself and are related to some object. Extraverts are sociable, and seek contacts with physical realities. They tend to act before they think, and all their emotions pass immediately into action or speech. They depend very much on their environment, and may change in temperament, from cheerful to depressed and back again, as their environments change. They will often sacrifice their better interests for the sake of company, and they are happy when they have many friends and acquaintances. Consequently they seek group activities such as parties, dances, amateur theatricals. They enjoy team games in particular, and are well pleased with themselves if they are leaders of their sides. They enjoy publicity, and are not easily embarrassed, so they tend to wear bright clothes and to meet strangers without shyness or self-consciousness. Often they appear to have no ambition in life, enjoying each moment as it comes. They are inclined to chatter and to be easy-going. Consequently they tend to be frequently in trouble at school, but they take their punishment without bearing malice. They express their emotions freely and infectiously and

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are often popular because they laugh easily. They are inclined to play the fool, and in this way often wound acquaintances unintentionally: whereupon they are profuse in their apologies. A list of tendencies pointing to extraversion may easily be composed by setting down the opposites of the items in the list for introversion.

These qualities will appear with different force in different people, and in many cases it will be difficult to tell to which end of the scale the child inclines; for we shall find that on some occasions they reveal introvert, and at other times extravert characteristics. Moreover, when making judgments we must examine evidence carefully, for a superficially extravert action may originate from introversion; aggression, for example, may result from the emotional conflicts of an introvert. Again, we must be careful that children are ascribed to the right end of the scale, that is we must remember that "A" is extraversion;<sup>1</sup> if we do not, the assessments of two teachers may be the same but one may appear as "E", and the other as "A".

The following scale is suggested as a basis of experiment.

A.	B.	C.	D.	E.
Extraversion				Introversion
Very interested in world and people, very active, reacts quickly to environment.	Interested in outward events but some introspection, expresses emotion in action.	Balanced thought and emotion fused to control action. Sense of own individuality but conscious of social purpose.	Interested mainly in self, and inclined to hide feeling, occasionally bursts into action or expresses feeling (although mainly to individuals).	Interested in self only, hides all feeling, expressionless. Shuns contact with people and real world. Persistent day-dreamer.

Some clinical psychologists have attempted to classify people on a scale ranging from schizophrenia to the manic-

<sup>1</sup> A useful mnemonic is "A" for extrAversion.

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depressive psychosis or cyclothymia. Classification of persons under this scheme should only be attempted by persons with clinical experience. But it is possible that teachers may be able to help in diagnosing cases early in their development, and so do something to recover that proportion of the cases that will yield to treatment. But the greatest caution is necessary. The teacher should refer his suspicions to the medical officer or the psychologist, and on no account should he take action on his own. It is still very doubtful whether the teacher should concern himself with these diseases, because they do not develop definite characteristics until the age of about fifteen years. We have mentioned them here because the terms are being used rather freely in these days—for example by the film producers—and the teacher ought to be alive to their real significance. In order to make their nature clearer we quote lists of the qualities associated with these diseases. Schizophrenia <sup>1</sup>:

Antisocial, reclusive, surly, hard, unresponsive, cold; earnest, extreme, spiteful, tightfisted, superstitious; rigid, tyrannical, vindictive; subjective, inert; hypersensitive, idealistic; unhappy, frustrated, dour; hostile, paranoid.

Cyclothymia (Manic-depressive)<sup>2</sup>:

Depressive States	Manic States
1 Sadness	Excitation
2 Motor retardation up to stupor	Hypersensitivity
3 Retarded thinking	Flight of ideas
4 Delusion of self-reproach, depersonalization, hypochondriasis	Delusion of grandeur, mental and physical
5 Suicidal ideas	Aggressive
6 Loss of sexual desire	Increased sexual desire
7 Sallow complexion	Ruddy complexion

<sup>1</sup> From Cattell "Description and Measurement of Personality," p. 313

<sup>2</sup> "A Textbook of Medicine," ed. by Sir John Conybere, p. 1048

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### INTERPRETATION OF THE ASSESSMENTS

When the assessments have been made, they should be studied with care; for very often it will be found that many of the weaknesses revealed are not inborn and may be reduced or remedied by special treatment. Many of the supposedly inherited evil traits apparent in some children have been shown in the child-guidance clinics to be due to lack of affection, a sense of insecurity arising from an unstable environment, or to lack of good training in infancy. Home conditions and the influence of parents are large factors in moulding the child's disposition. The important conclusions for us are that there are large acquired elements in character and that, although some weaknesses are inborn and therefore beyond our control, much can be done in the re-education of the dispositions of children. This throws a great responsibility on the teacher—a responsibility which can be met only by the careful use of record cards.

There is a grave danger that the child will be regarded as the sum of the traits revealed on the card. Each child is a living entity, and when we attempt to split him into his component parts we destroy him. Moreover, qualities of disposition cannot be isolated. They exist only as a means of describing behaviour—the actions, moods, attitudes, and feelings of the child. We must, therefore, be constantly watching to see how the traits are unified in the character of the child. It would be foolish, for example, to look upon a "C" assessment in co-operation as an indication of weakness, if the boy so assessed had marked powers of leadership. The child who is low in self-confidence may be high in conscientiousness. There are as many ways of unifying all these varied traits into a single being as there are personalities.

Again, we must remember that the system of unification

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in a child may be constantly changing, for the traits are often acquired, and those which are innate often do not reach maturity until late in life. It is impossible, therefore, for a teacher to give a complete and final verdict about any child. The assessments of the qualities of the child's disposition should be supplemented by a character sketch of him, and this will require the insight of the artist as much as the careful observations and measurements of the scientist. We must at all times think of the child as a living organism continuously adjusting itself to its environment, in short, as a person.

Certain difficulties need special care. Professors Oliver and Field suggest that the following should be noted<sup>1</sup>: "apathy, timidity, bashfulness, over-submissiveness, anxiety, excessive day-dreaming, irritability, excitability, outbursts of temper or crying, jealousy, over-aggressiveness, bullying, mannerisms, difficulties related to sex, truancy, and delinquency." The list given for infants by Dr. Susan Isaacs<sup>2</sup> is "destructive, over-aggressive towards other children, over-submissive to other children, apathetic, moody, erratic in purpose and interest, suspicious, bashful, anxious, stubborn, defiant, liable to outbursts of temper, irritable towards failure, self-conscious, refuses to play, refuses to play except as leader, dreamy, fond of self-display, seeks adult attention, needs constant praise or encouragement, excitable." Both lists merit the careful consideration of teachers, who will probably be able to add other difficulties of their own such as lying, stealing, lack of courage, etc.

We are not concerned merely with the psychological analysis of these weaknesses, but with their effect upon the development of the child. We must therefore, wherever possible, provide remedies. In order to do this we must

<sup>1</sup> "The Educational Guidance of the School Child," p. 97.

<sup>2</sup> *Ibid.*, p. 89.



adjust the environment to the child. We have already seen how the environment should be adjusted to the intelligence of the child, but the adjustment to disposition is a far more difficult problem on which much research work remains to be done. Each case will have to be considered separately in order to give each child a full opportunity to develop healthily his propensities, for both under-development and over-development may produce very undesirable results. In the same way as the continual inhibition of a natural desire produces mental maladjustment, too frequent stimulation will produce unhappiness for the individual and for those with whom he comes into contact. The woman who inhibits her maternal instinct becomes cold and cynical, whilst over-indulgence produces the person who wants to "mother" everybody. Similarly, a child encouraged too much in leadership will adopt too forceful and too unsociable an attitude, whilst the child who is not encouraged at all may be too dependent on others and unable to make his own way in the world.

The problems caused by environmental influences should not be overlooked, and need careful investigation. In the hours when he is not at school, parents, friends, films, the radio, the press, the locality in which he lives, and the world in general (who can forget the influence of the war?) play on the child. Each impact affects his personality; many of them we feel make him less worthy as a citizen and as a man. The records will help us in studying these problems and may enable us to find the means of making all these factors of environment much more beneficial and less harmful.

Let us consider a child who exhibits marked signs of introversion. In school such a child will appear lonely, little interested in formal lessons, disinclined to play games and indulge in physical activities. We shall find

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him standing in quiet corners; he will very often be unable to answer oral questions and he will do his written work very slowly—sometimes at the end of a composition lesson he will have written only a few words; yet we shall see from the work he has done that he has intelligence and has grasped what we have been teaching. His face will be expressionless and he will rarely smile—he is ironically nick-named “Smiler” by his classmates. Sometimes we shall find that, if he is due to stay at school for dinner, he will hide himself in some corner and go without his meal rather than eat in public. He may find joy in music, poetry, reading, and painting. Our task here is to so adjust his environment that any drives which tend to extraversion are fostered. He must follow his own innate make-up and yet we wish him to be at peace with his environment. It often helps to give him some small responsibility to bear, such as the opening and closing of the curtains at the performance of a form play, or the distribution of books to the class. He will probably do these tasks badly at first but with encouragement will improve and may be given greater responsibilities. Such a child often benefits from taking part in choral speaking or singing: as one of the choir his own personality is forgotten and he attempts expression which would be beyond him if he had to speak or sing alone. But the teacher must be careful to see that he does not stand silent and allow the rest of the class to hide him. He may eventually be given a line to speak alone or even a few words in the form play: school plays should be cast with one eye on such children. Above all the teacher should seek opportunities of talking to the boy, quietly and in private, about everyday things and he should persuade his colleagues to do the same, so that the boy becomes more used to social contacts. But the teacher must be cautious: a sense that he is being picked out for special treatment will only make the child

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worse. Many a neurotic or psychotic adult could have been a better balanced and healthier citizen if direction in school had been wiser and less lacking in understanding.

In this chapter we must limit ourselves to this single concrete example, for our purpose is not to suggest remedies but to outline a method of recording child-development which will help the teacher to discover weaknesses, their causes, and perhaps their remedies. For further information about treatment, books on child psychology and child guidance should be consulted. In many cases treatment will not be within the province of the teacher, but will be the business of the psychologist. But the teacher will be responsible for entering a brief account of the "treatment given" in the appropriate space on the record.

This section of the record is of supreme importance, but it is also the most difficult to complete and interpret. The possible rewards, however, are so large—our decision may be the starting-point of mental happiness in adult life—that it behoves us to enter carefully the information we have gleaned and to ponder it well. A child who has little opportunity of fully exercising his innate intelligence in school, will, in later life, find much in the world on which to sharpen his wits: but the child whose emotional life is never developed at school will find little in his adult life to help him and may easily develop anti-social habits which may never be eliminated. The power of the teacher and the school is illustrated by the effects of environmental changes upon children in recent years; so many children who are now at odds with the world would have developed normally in pre-war Britain.

It is quite possible that research will indicate different uses for these dispositional assessments. It may well be that for some subjects, for example music and painting and composition, it may be better to group children in

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classes according to their dispositions rather than according to their I.Q's. Vocational guidance, too, offers a wide field for investigation. "Intelligence" should not be the sole criterion in the selection of a career; disposition may well be a deciding factor—a schoolteacher is not made from an introvert, however intelligent he may be, and an extravert would be very unhappy as a lighthouse-keeper.

Many carefully made detailed observations are necessary before we shall know what qualities of disposition will produce strong well-knit personalities and harmoniously developed characters in any given environment. Teachers have a unique opportunity of contributing to this knowledge and of making a mentally healthy and happy nation.

## CHAPTER IX

### ENVIRONMENT

IN the previous chapters we have been concerned with special aspects of the individual child. As we mentioned in the introduction, there is a danger that each of these aspects may be regarded as an entity, instead of as a mere facet of the child which we see when we look at him from a particular angle. We must always remember that all traits are intricately interwoven in the personality of the child, and, when we are considering him, we must endeavour to see as a whole the pattern into which the threads are woven. Our concern is with the entire personality of the child, not with the particular qualities or the isolated abilities of which he is composed; for individually the traits can reveal little of the true nature of the child—it is their blending or their clashing in the complete person which will show us how he is likely to behave in any given situation. The child's harmonious development or maladjustment depends upon his ability to adjust himself to his environment or to modify his environment to suit himself, for on his interaction with his surroundings will depend the fulfilment, or the failure, of all his potentialities for his own happiness and for the benefit of mankind. What we have to study then are "the interactions between a 'personality' and an 'environment'—the behaviour of a dynamic mind in a dynamic field of which it forms a part. Hence the complete scheme of enquiry must embrace a sociological study of the environment as well as a psychological study of the child."<sup>1</sup> So far we have dealt with the environ-

<sup>1</sup> Sir Cyril Burt: "The Assessment of Personality," *The British Journal of Educational Psychology*, XV, p. 107.

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ment only casually; it is necessary to consider it in greater detail.

## PERSONAL DATA

First let us deal with a few points of the child's personal history which to some extent condition his environment. It is essential that this information should be treated as confidential; for this reason a simple code is often used when entering the names on record cards—*e.g.*, Rbsn Jn stands for John Robinson.

(a) Ages should be recorded uniformly throughout the authority, so that all calculations based upon them—for example, mental and attainment ages—will be relative one to another. It is necessary, therefore, to fix a date as the basis of all calculation. The date of the end of the official school year, July 31st, is the most useful. The average age and mean mental age of each class should be known.

(b) The position of the child in the family should be entered as a fraction or as a series.  $\frac{2}{4}$  means that the child is the second of four. The series method is better because it gives more information, by indicating the ages and sexes of the other children. Thus, 15 B, 11 G, 9 B, 7 B, indicates that the child whose record we have is a boy of 9, with an elder brother of 15, an elder sister of 11, and a younger brother aged 7. Instead of the age, the year of birth may be given. This enables us to record the subsequent birth of other children. Thus in the series above we should have B 33, G 37, B 39, B 41.

(c) The occupations of and other relevant material concerning both parents should be entered, because they afford a key to the financial position and physical condition of the home. To follow the emotional development of the child, we must know, in addition, the relationships that exist between the mother and the father, and between

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the child and his parents, and between the child and other members of the household. The deaths of parents, separations, and divorces should also be recorded.

Many people will object to giving such information, if they are asked for it directly by a teacher or if the child is questioned about it. Parents may regard any attempt to collect it as unwarrantable interference in their private lives. We must recognize and honour this wish of the parents. It is better for the information to be unknown than for the mother and father to take up an unco-operative attitude towards the school. Usually, however, the parents will volunteer the information themselves to a particular teacher, especially the headteacher. It is actually quite easy to collect the information, for much of it may be picked up unsought in the casual conversation of the child, or may be passed on from the medical record card, the school nurse, or the enquiry officer. It should be obtained as unobtrusively as possible, and must be treated at all times with the strictest confidence.<sup>1</sup> It should not be allowed to prejudice the teacher against the child in any way, for its one legitimate use is for the benefit of the child.

### THE HOME

The most important environmental influence on a child is that of his home. Much will depend upon the financial position of his parents, for it will determine their ability to feed, to clothe, and to house him adequately. Poverty brings in its train a multitude of troubles. For example, many children suffer from the ill effects of bad housing conditions. Unable to afford a house far removed from their places of work, the poor tend to live in small houses

<sup>1</sup> It is important to check, as far as possible, statements made by the parents, for often the difficulty is not the antagonism of the parent but the inability of the parent to speak frankly to the teacher.

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huddled together in the most industrial parts of the town. Consequently many children have no place for their recreation other than the streets. Apart from the effect upon their physique, such an environment tends to produce bad habits and unhealthy attitudes of mind. The spirit of adventure of the children finds itself confined, and often seeks an outlet which may be distressing to other people in the neighbourhood. It may express itself by breaking the panes of glass in street lamps, by hooliganism, by assaults on people against whom they believe they have a grievance. For these purposes, they tend to gather themselves in gangs. This gives them a false kind of courage, which may eventually lead them into house-breaking, theft, and arson. The child who has a garden and a sandpit where he can roam and play at will has a great advantage over the less fortunate slum children. The youth group movement attempts to find outlets for this gang spirit along healthy lines in sports, pastimes, and in constructive social projects. Another ill consequence of inadequate housing is the lack of sufficient sleeping accommodation; boys and girls sleep together or in the same room as their parents. This often is the cause of unhealthy sexual curiosity, and may lead to the formation of undesirable habits.

Children will remain unconscious of their home environment so long as their friends are in a similar condition, but when they come into contact with other people who live in more favourable circumstances many become discontented and conscious of their own poverty. This happens sometimes when poor children are moved into the atmosphere of a grammar school; they feel out of their element and, in an attempt to adjust themselves to the economic conditions of their fellows, they sometimes descend to stealing; in some instances they admit defeat by truancy. It is results of this kind which have led



Sir Cyril Burt to the conclusion that "a realistic policy must take frankly into consideration the fact that a child coming from this or that type of home may as a result be quite unsuited for a type of education, occupation or profession, which lies at an excessive 'social distance' from those of his parents and friends".<sup>1</sup> In an endeavour to help these children, it has been laid down as a principle of English education that financial difficulties must not be allowed to stand in the way of the full development of a child's abilities. He is provided with scholarships, free meals, free milk, outfit allowances, and travelling expenses. But there are still great difficulties.

Because the parents do not possess the ability to run a home well, their children will suffer in many ways. Usually children from such homes will show signs of malnutrition, resulting from unsatisfactory feeding; their clothes will be unbrushed, dirty, torn, ill-fitting; their faces, hands, and bodies will be unclean; they will show by their dull and drooping appearance the need of sufficient sleep; they will be often unpunctual, and frequently absent; they will lack good manners; some of them will show the lack of spirit common in those who are drudges in the home. Bad management is not confined to poor homes, however. A wealthy home ill-managed will be worse than a poorer home well-managed. But the best of managements in a poor home cannot rid it of the strain and worry of financial struggles; and the troubled atmosphere affects the child adversely.

The child is affected not only by the economic and material conditions of his home, but also by the emotional atmosphere in which he passes his life there. If the emotional tone is serene and cheerful, then the child has a feeling of security and well-being; but if the atmosphere

<sup>1</sup> "Selection for Secondary Schools," *The British Journal of Educational Psychology*, XVII, p. 67.

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is tense as a result of domestic friction and family differences, then the child may be unsettled, unsure of himself and his surroundings, incapable of evaluating his experiences at their true worth, and emotionally unstable. When there are quarrels between parents, when the child is separated from one or both of his parents, when he is an unwanted child, or when parents would have preferred a child of the opposite sex, it is difficult for him to adjust himself to the people around him with complete happiness. Similar emotional difficulties occur when a parent is unable to see life from the child's point of view and insists on denying the child the right to his own opinions—a child who likes going to school may be confused by a parent who disliked school intensely; a child whose mother is interested in social activities but not in babies will be unable to reconcile his love with her neglect. The sons and daughters of parents who are separated or divorced and illegitimate children are in positions of peculiar difficulty. Children who are brought up by step-parents, by grandparents, or by other guardians, and even those whose parents are away at work all day, feel that life is strange and unsatisfactory. The child needs a sense of security, and this depends to some extent on the family relationships being sound and healthy. When these relationships are disturbed, they produce emotional conflicts, which are expressed in abnormal forms of behaviour—constant crying, attempts to win affection by exhibitionism in various forms, the flouting of authority, or, in extreme cases, malpractices and delinquency.

The influence of brothers and sisters on the development of the child should not be overlooked. They may be friendly, helpful, and encouraging. On the other hand, they may be inclined to tease, to bully, or to nag the child, so that he finds his surroundings somewhat uncongenial

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and irritating. Although the jealousy of brothers and sisters is to some extent normal, in some children the effects may be grave. When the other members of the family are older, there is a danger that the child will be either babyish and petulant or precocious and impertinent, according to the treatment that he receives from his family. The time of greatest danger is when he is entering adolescence, for he may be seriously misled by his elder brothers and sisters, who, perhaps wishing to show how grown-up they are, make a boast of their ill-digested knowledge. We should, too, notice the attitude taken up by other children towards a child because of his home conditions. This will not only reveal much information about the other children, but may help us to understand the difficulties of the child himself. For a sensitive child unkind treatment by his fellows can be very painful and permanently damaging.

## ATTITUDE OF THE PARENTS

The attitude of the parents towards a child is of great importance, for this is reflected in many ways in the child's behaviour. The standard of discipline they adopt and the way it is imposed reveal the attitude clearly. Far too often it is a mere matter of rewards and punishments, with no attempt to make it an expression of the needs of human beings and of society as a whole. Weak and unreflective parents try to drive children their own way by threats and noisy outbursts. In some households the mother and the father have different codes; this difference encourages cunning in those children who play one off against the other, but leads other children into confusion. Some parents are too strict; others too indulgent. Where a rigid attitude is taken up and the child is made to conform to strict principles, there is a

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strong tendency to revolt: this may be observed frequently in the children of parents of narrow religious or political views. Often it produces in the child, when he behaves in a manner natural to himself but contrary to the dictates of the parents, a false sense of guilt. It is not surprising that children of these parents are often secretive, underhand, and suspicious. On the other hand, many mothers and fathers are too lax, and allow their children to go their own way without putting any real check upon them. We have even come across cases where the parents have actually encouraged their children in conduct which is generally disapproved: a woman recently was found to be giving her child monetary rewards for every article she stole from shops and was making her practise how to steal: in the re-education of this girl, it was difficult to make her realize that the child who did not seize her opportunities to take things was not a fool.

It is difficult to maintain a balance between firmness and kindness when dealing with our own children. Many mothers keep their children as babies too long, and do not allow them to take risks or to experience life for themselves; they are protected from every difficulty, spoken to in so-called "baby language", and in some cases are not allowed to learn to dress or feed themselves even at school age. Such children are unhappy when they first come to school, and they may go on feeling afraid of other people and being anti-social all their lives. They will tend to be rebellious and obstinate, and often will become neurotic. One of the sad features of this treatment of the child by the mother is that nearly always it has an effect opposite to that desired by the mother; instead of loving and cherishing her, the child usually resents his mother's depriving him of independence.

Fortunately, authorities are taking steps to educate

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parents to behave wisely towards their children, but so far little has been done beyond the nursery school age. Most fathers and mothers are willing to make sacrifices for their children at this tender age, but they do not realize the vital importance of doing so throughout their school careers. During the child's infancy most of them are willing to give special consideration to him, but soon they expect him to behave like themselves and to make his life fit in with theirs. He is allowed to go to bed late, to eat all kinds of food, to go to the cinema on unsuitable occasions, to go on long day trips often involving great physical and nervous strain, and to live all the hours he is at home with the noise of the wireless programmes as a background. Rarely does he have opportunities for reading, study, or quiet hobbies. He may have toys to play with in plenty, but will probably be without room to run about—for he must not interfere with the normal arrangement of the house. If a child is to develop healthily he must be allowed to follow his own interests, not those of his parents; he must have opportunities to widen his experience and to satisfy his creative desires; he must be given sufficient independence to establish confidence in himself; and he must be allowed to meet other people on his own, so that he will be ready and unafraid to seize the adventures which daily life affords him.

### THE CULTURAL BACKGROUND

The cultural atmosphere in which a child lives may have a profound effect upon his life. Dr. Watts<sup>1</sup> concludes from the results of his tests that "Favourable home conditions in the early years of childhood give background and meaning to what is read to such an extent that they

<sup>1</sup> "The Language and Mental Development of Children," p. 111. In the same book, pp. 25-26, Dr. Watts suggests that a child's performance in an intelligence test is influenced by his cultural background.

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leave the child from an illiterate home severely handicapped in his progress." And he is in agreement with most teachers when he states<sup>1</sup> "It is the dull child from the low-grade home, where little reading is done and where little improving conversation is heard, who constitutes the teacher's constant problem". Professor F. J. Schonell<sup>2</sup> has reached a similar conclusion: "By far the greater amount of scholastic backwardness amongst normally intelligent pupils is associated . . . with unfortunate environmental and emotional experiences".

The ideas current in his home and in his district tend, with slight personal modifications, to become his. It is very difficult for any person to break away from these local bonds, for to break away from what is acceptable is often to run into insecurity. How often do we find boys and girls speaking with one pronunciation in school and another in the streets because they cannot overcome the pressure of environment. So we shall find that the attitude of the child towards education, his future career, religion, and life in general are to a large extent those of his family and of the people in the neighbourhood. "The dominant incentives that emerge during the post-primary stage are profoundly influenced by the 'ideology' prevalent in the child's own circle."<sup>3</sup> Often children who are ambitious are deterred by their playmates from striving for careers which they would like to pursue, because they are jeered at for setting themselves above their neighbours.

Many parents allow their children to go to grammar schools in the hope that they will gain a more lucrative post and, without any consideration for their happiness, take them away before they have completed the course, in order that they may earn money as soon as possible.

<sup>1</sup> "The Language and Mental Development of Children," p. 91

<sup>2</sup> "Backwardness in the Basic Subjects," p. 5

<sup>3</sup> Sir Cyril Burt "Selection for Secondary Schools" in *The British Journal of Educational Psychology*, XVII, p. 65.

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All the time the children are at the grammar school, the parents dislike their having to do homework, make no attempt to give them the quietness and facilities necessary, show no interest in intellectual work, and do not make the effort to understand their emotional and social development. An article in *The Times Educational Supplement*<sup>1</sup> concerning the poor boys in a grammar school in Manchester, in the period 1934 to 1945 inclusive, revealed that 47 per cent left before completing the course, and of those who completed the course nearly one-half failed the School Certificate examination. They had been unable to overcome environmental interferences with their courses. Similar evidence was noticed by Sir Cyril Burt : " it is noteworthy how often bright children from humbler families seem handicapped by a want of persistence and emotional stability. Many seem to lack the spur of ambition, to keep them working assiduously at their harder scholastic tasks." <sup>2</sup> This led him to declare in the same article that the child's " future development will depend, not merely upon his innate mental capacities and temperament, but upon the interaction between this innate and slowly maturing endowment and the field of social forces in the midst of which the child and adolescent matures ". Amongst these social forces Sir Cyril Burt lists " poverty in the home, worries over family affairs, lack of facilities for homework, lack of sympathy (among parents and friends) with the academic approach, lack of any attempt to foster social or intellectual ambitions, discrepancies or conflicts between the ideals of the secondary school and the ideals of the child's own relatives or of his friends and acquaintances outside the school ".

Our illustrations and the words of Sir Cyril Burt apply

<sup>1</sup> January 10, 1948 p 21

<sup>2</sup> " Selection for Secondary Schools," p 65.

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to children in the post-primary stage of their education ; but the underlying principles apply at all stages. A child who lives in a home where good journals and books are used regularly, where an interest is taken in intellectual and æsthetic pursuits, is likely to be stimulated to value a cultured life. How much better off is he than the child who has no such encouragement ! In the first home good manners, courtesy, self-control, tolerance, evenness of temper, and kindness are likely to be valued, and the child will unconsciously accept them as his own standards of behaviour. In a home where everyone is selfish, quarrelsome, discourteous, ready to indulge his emotions, one cannot expect to find a boy who does not suffer in some way from these unhappy characteristics. The one home will send the boy out into the world to be happy, to seek adventure, to serve his fellows ; the other home will send him out more urgently to earn a living, to seek security for himself, and to preserve himself against the troubles of the time. It is one of our tasks to give all boys and girls equal opportunities, and to ensure that ability is not rendered fruitless because of social blight. First we must record the child's cultural background and then we must find a way of enabling him to overcome his difficulties.

### CO-OPERATION BETWEEN HOME AND SCHOOL

" Home and school are so bound up together that it is imperative for teachers and parents to have a real understanding one with the other." <sup>1</sup> If each has a different code of behaviour, a different standard of discipline, a different attitude towards life in general and towards education in particular, then the child must either reject one and accept the other, or attempt to compromise by adopting one code of behaviour at home

<sup>1</sup> F. J. Schonell : " Backwardness in the Basic Subjects," p. 48.



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and another at school, or he must live in confusion. In none of these situations is he happy; in none of them will he develop to the full all his potentialities. Fortunately, staffs and parents are meeting more frequently not only at school functions, but at special interviews and parents' evenings. Usually it is easy for the headmaster to form an alliance with the parents, but often it requires great tact and firmness. Because of its importance, the co-operation of parents should be assessed on the five-point scale, recorded, and any difficulties noted.

Lack of co-operation with the parents will merely emphasize the differences between the environment of the school and that of the home. Perfect adjustment at school may well be accompanied by a very unhappy state of mind in the home; for a success at school may be a failure in the world outside. The boy who is regarded as clever by his teachers and is, therefore, accorded special privileges by them may, at home, resent being made entirely subservient to his father's whims and wishes. The converse is also true. The boy who is "spoilt" at home will very often prove a nuisance at school, where often he must control his personal whims for the benefit of the class as a whole.

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The school environment should be made as attractive and pleasant as possible. The rooms should be full of light, colourfully painted, hung with good pictures, and, whenever they are available, gay with flowers. Cheerful surroundings help to make the children happy; drab walls and dirty, untidy classrooms and corridors tend to make them depressed and dull. Teachers should remember that they, too, are a vital part of the environment; their general appearance, their dress, their speech, their

manners, their attitudes, and their ideas will be reflected in their pupils. Untidiness, for example, spreads itself from the teacher to the classroom, and so to the children, to their work, and to their attitude to life; discipline weakens, work deteriorates, emotional disturbances and misconduct arise. Again, a teacher who is not content, who is ill at ease with his surroundings or divided against his colleagues, may do great harm. We must do all that we can to make it easy for the children to adjust themselves to the school environment: it is of great assistance, if we are ourselves in happy states of mind and if our classrooms are as pleasant as we can make them.

These duties fall most heavily upon the teachers whose duty it is to receive the new entrants. The child is plunged into a new environment rather suddenly. Often he has left his mother for the first time; the room is much larger than those to which he has been accustomed at home; the people are strange. He has no control over his new surroundings, and cannot do the things which he would do at home. Moreover, he cannot avoid his new circumstances, in the same way as he avoided strange situations and difficulties at home, by playing quietly in a corner with his familiar toys or by weaving his phantasies—although the judicious use of “free activity” will enable him to do so for part of the time. The problem of the teacher on these occasions is difficult to solve, but the effects of its solution may be felt throughout the child’s school life; prejudiced against the new surroundings in these first few days, a child may dislike school throughout his career. The child’s behaviour at entry should be noted with especial care and recorded on the card.

The atmosphere of the school and of the classroom is a matter for careful thought. The primary purpose of education is not bookish learning, but the development

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of the child physically, emotionally, socially, and morally, as well as intellectually. Accordingly, lessons should be lively and full of the joy of adventure and exploration. They should bring to the children new experiences which will give them an increasing sense of their own competence and of the happiness that there is in life. Unfortunately, far too many schools are examination ridden. Perhaps the worst sufferers are the children in Junior Schools, who often begin to prepare for the examination for selection for secondary education immediately they enter the school.

Another factor conditioning the atmosphere of a school is the form of discipline which is adopted. A happy teacher who finds joy in all his dealings with children, and who does not mind making personal sacrifices for them, will find his class is happy, contented, and progressive. The teacher who drives, and who does so by fear, will find work hard and unpleasant, and his pupils will suffer from strain and fatigue; they will be dull and bored with life. Other teachers, realizing this and having a smattering of psychological information about "repressions" and "inhibitions", have so over-indulged the children's wishes that their lessons are chaotic.

We must remember, when considering the question of discipline, that the child is a member of society and must learn to live as a member of a community; he must learn that, whilst he must make every endeavour to develop his own personality and character, there are occasions when he must modify his own desires for the sake of his fellows and that, if he fails in his duty to his colleagues, society will punish him—the punishment may be his loss of a sense of security, it may be the loneliness which comes from being shunned by his comrades, or it may be some physical pain. Miss Burbury sums up the situation well.<sup>1</sup>

<sup>1</sup> "Child Guidance," p. 8.

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"Every child, as he grows through childhood and adolescence to maturity, must learn first to assert himself against society and second to accept society against himself. In infancy his physical and economic dependence and his lack of experience combine to induce him to conform to the dictates of others against his own desires, since only by his contact with them can he feel secure. As he develops and his experience grows, he realizes that there may be diverging views and he begins tentatively to express his own. At this stage it is just as important that he should have freedom to do this as that he should have freedom to walk, and we should help and encourage him, neither holding his inexperience up to ridicule nor filling him with a sense of guilt, because we feel our power threatened by his first steps in independence and, therefore, treat them as moral lapses. Thus he can learn gradually to tolerate the insecurity of standing alone—an individual. Along with this lesson must come its other half, that always we live in a society which expects us to adapt our individuality to its welfare."

The teacher should be kindly, but firm, so that the children will look upon him as a friend on whom they can rely to deal with those problems aroused by their environment which they cannot deal with themselves. The weak teacher has not the child's confidence in this matter. At the same time the child must be allowed sufficient independence to develop his abilities and interests. But he must learn that the privileges of freedom impose responsibilities, that he has a duty to his fellows, that he should aim at being constructive rather than destructive. All schools, therefore, should arrange opportunities for their children to meet in social activities, so that they may learn the graces of life, courtesy, and a sense of responsibility to others, as the basis of truly happy life in the community. The corporate spirit of the school, and the

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social training it gives, will do much to fashion the child's outlook on life.

It is clear that, if we are to deal adequately with the development of a child, we must know something of his environment. The record card should, therefore, have some reference to the home conditions, to the family's cultural outlook and attitude towards life, to the willingness of the parents to co-operate with the school, to the chief characteristics of the neighbourhood from which the child comes, and to how far the child is likely to be influenced by that environment.

### CONCLUSION

In the training of a child we shall endeavour to enable him to develop both as an individual and as a member of society. As an individual we shall try to provide him with an education which is suitable to his general mental capacity, his special aptitudes, and his interests; as a member of society we must help him to subordinate his own personal wishes to those of the group as a whole, to understand his responsibilities as a member of a community, to sacrifice his time, energy, possessions, and abilities for the service of his fellows. There is grave danger today of over-emphasizing and misinterpreting the first aim to the neglect of the second, so that instead of self-discipline there is a tendency to licence; this is seen in the greater insecurity of modern life, in acts of violence and wanton damage, in purposeless theft, and in the social disintegration arising from a lack of a sense of values. Below the surface of this perceptible unsatisfactory behaviour there are the great conflicts in the minds of men, women, and children, displayed in instability, anxiety neurosis, delinquency, and mental derangement. These are grave problems of maladjustment which the teachers of the country can do something to alleviate, if

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they educate the children in a way which results in the full development of the individual as a member of a healthy society. By the judicious use of record cards, as a means of studying the individual and his background, much may be done to achieve this aim.

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### EXAMPLES OF RECORD CARDS AND THEIR USE <sup>1</sup>

1. *FREDERICK WHITE* is a boy of normal intelligence without any serious physical deficiency, who is unhappy because he cannot adjust himself to his environment. The cause of the maladjustment is the great anxiety of his parents that he should be an ideal boy.

To a casual glance his home appeared to be a good one. His parents were diligent, "respectable", working-class people who tried to live up to high standards. Their house and the part of the town in which they resided were better than is usual for people of their financial level. The material background which they provided for the boy was good, but they failed to understand the real needs of the child, and tried to make him conform to adult standards. Very early in his infancy they decided that they would like him to go to a university and, without considering what his natural abilities were, pressed him towards that goal. Before he came to school they attempted to teach him to read, and for some time after his entrance they plied him with homework each evening. In appearance and behaviour the same high standards were set and, rather than have him ill-dressed, the mother continued to dress him long after he should have been able to do it himself. When he came to school he was

<sup>1</sup> The school record cards used as illustrations reveal the educational development of real children whose identities are, for obvious reasons, not disclosed; but, since the form of record card here suggested has not been in use for any length of time, it has been necessary to refer to other forms of record card and to notes made by the teachers for some of the information.

Blank copies of these cards (for use in Infant, Junior or Secondary schools) can be obtained from the University of London Press, Ltd., Warwick Square, London, E.C.4.

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incapable of looking after himself and of keeping himself neat and tidy. His parents tended to segregate him from other children, for they did not like him to return dirty and "like a ragamuffin". At times the boy sought relief from such severe discipline by running away or doing wilful damage. On a number of occasions he was picked up by the police after being "lost" for a day or two. When he returned from his excursions he was usually thrashed by the father and sent to bed.

During his first weeks at school the boy showed considerable animosity to his teacher. He found it difficult to mix with the other children, and this difficulty was increased when other boys teased him for his baby ways. In reality, he was anxious to make friends, and so was easily led into mischief and hare-brained escapades. After he had misbehaved, he attempted to avoid what he imagined would be the consequence of his action by leaving the school: he had to be watched at break, at dinner-time, and when he went to the lavatory. He showed such anti-social behaviour as pinching other children, punching them when they were not looking, and splashing them with paint. During his periods of free activity his first choice was usually a hammer-block, and when he had tired of this toy he went around with the hammer, interfering with the activities of the other children. If a boy retaliated, he quickly lost his temper, screamed, waved his arms about, and kicked the furniture. Some children were frightened at first, but later those boys who were amused by his exhibitions provoked him deliberately. This made him more self-conscious and awkward. In an attempt to cover up and to gain prestige, he sometimes behaved in a silly manner to make the other children laugh; he became the fool of the class.

His school work was unsatisfactory and below the level of which he was capable. He showed little interest in



class activities and lacked powers of concentration; he usually began a fresh task earnestly, but soon tired or was distracted; he often gave absurd answers because he did not listen carefully to the questions asked. His writing was very bad indeed, for he had little control over his finger-muscles. This lack of muscular co-ordination appeared too in his clumsiness; he was constantly dropping his crayons and spilling his paint. His speech was marred by a slight stutter, and in conversation he was embarrassed and spoke in jerks.

He did not sleep well, for he was disturbed by dreams of a nightmarish character. On occasions he talked and walked in his sleep.

During interviews with the parents it was revealed that the causes of the maladjustment in the boy were their setting of too high a standard and the severe discipline with which they attempted to keep him up to the level they desired. It was suggested to the parents that they should discontinue homework, allow him to play frequently with other boys, make him fend for himself whenever possible, encourage rather than penalize him, and, above all, that they should not make plans for his future until they had found for what he was best suited by nature. The teachers dealt with him in a kindly manner but firmly. His work was compared with what he had done previously rather than with that of the rest of the class, and improvement was praised. He was given parts in dramatizations, allowed to conduct the percussion band occasionally, and trusted to do little responsible jobs, such as collecting paint-pots. The teacher was sympathetic and friendly, and encouraged him to talk to her about the things which interested him.

Before he left the Infant School he showed considerable improvement in all directions—in his work, in his personality, and especially in his attitude towards other people.

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change from "E" to "B" in his attitude to the teacher is noteworthy.) The parents were co-operating well with the school, and it seemed likely that the boy would develop normally. It is significant that he had not "run away" for some time.

2. *GRACE STONE*. This is the case of a child with good innate mental ability who was handicapped by physical deficiency.

The girl suffered from asthma, which caused her to be absent from school frequently. When present she showed little inclination to persevere in her work and, if she had been disturbed in her sleep by an attack of her illness, her vitality was very low indeed. When she was forced to stay at home she read, painted, and played the piano, and she spent her time on these subjects when other children were engaged in more energetic activities; consequently her attainment in these subjects was only slightly affected by her absence. But in arithmetic she found it difficult to make up the ground she had lost, and her performance was well below what her general mental ability led her teacher to expect.

In her last year in the Junior School her attendance was better. This was due in part to the improvement in her physical condition, but there was a suggestion that earlier in her career she had been kept at home unnecessarily. When both the girl and her parents were anxious to get a place in a grammar school, she showed greater interest in her school work and greater perseverance. These, together with her improved attendance, resulted in better performances in the attainment tests.

She was a pleasant girl when she was well, and she entered with some enthusiasm into the corporate life of the school; she even wanted to play games and to take P.T., but had to be restrained. But she could not be

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relied upon to do a task, for she became tired and did not complete it. Because of her illness, she had had special care at home, and she tended to expect it at school—she was finical about her food, occasionally petulant, and at times resented discipline. On occasion she played nasty tricks on her comrades, particularly those who were good at games or academic work—she filled one girl's wellington boots with water and put chewing-gum in another girl's hair. These were probably attempts at compensation, but they were rare spasmodic outbursts, and were not typical of her behaviour. She tended to adopt a superior attitude to her colleagues, a characteristic which was common to all the family. There was a suggestion, too, which was also perhaps a characteristic of the home, of wanting to take all she could from the school and to give little in return.

There was little that could be done in the way of treatment for this girl, except to make sure that she avoided all conditions that were likely to bring on an attack of asthma. From all other points of view she was treated as a normal child, it being important to make sure that she did not develop the habit of using her illness as an excuse for other deficiencies. For her spasmodic anti-social tricks she was reprimanded firmly.

This example shows clearly the value of school records when selecting children for secondary education. The decision as to the best type of education for her is a difficult one to make. Both she and her parents desire for her a grammar-school training. Her I.Q. indicates that she is capable of following such a course successfully, but her attainment scores suggest that she will not be of the required standard of performance. Her English is satisfactory, but her arithmetic is only average; in a competitive examination determined by an aggregate mark she would be below the pass mark. But her teachers'

estimates of her special aptitudes suggest that these attainment scores are not true reflections of the work of which she is capable. Her school record suggests that with better health—and the medical record indicates that this is a probability—she should reach grammar-school standard. She is above average in verbal facility, in the manipulation of numbers, in drawing, in painting, and in music, and she writes stories and verses for her own amusement. It seems improbable that she will be allowed to become a doctor or a nurse, the professions she prefers. But she has also shown a desire to be an architect, and it seems therefore that she is most fitted to attend a school of art, with a view to obtaining a post as a commercial artist or in an architect's office. The decision should be given careful reconsideration in two years' time. Meanwhile, if the girl is to be educated according to ability and aptitude, she should be given a place in a grammar school.

3. *ROBERT JOHNSON* was a boy of superior intelligence, who did very well in his studies, but who had to struggle against two difficulties—his youthfulness compared with the other members of his class, and the financial troubles which arose from his being the son of aged parents.

His average I.Q. was 145. He entered the grammar school when he was 10 years 1 month old, and at 13 years 11 months obtained a good School Certificate. His father and mother were elderly people; the father became a pensioner whilst the boy was in his fourth year. Both parents were concerned about their financial future, and their fears were transmitted to the boy. Consequently, although he was obviously fitted for a university career, he was anxious to leave school as soon as he had reached the age of 14, in order to get a post which would enable him to help the family financially. At first he wanted any kind of office job, but later decided on a post in a solicitor's office.

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The effect of financial pressure upon his attitude is clearly marked in the assessments of his dispositional qualities in the fifth year—that is after he was 14 and had passed School Certificate. There was a decline in perseverance and conscientiousness, and he was less co-operative. He wanted to get away from school to earn some money. But fundamentally he had not changed. He was still much interested in books and intellectual problems, and, as a result of living in the less formal society of the sixth form, he had become more sociable, and more conscious of the problems of the community in which he lived (civic interest rose to “B”).

His marked unsociability in his early years seems to be the result of his circumstances. The solitary situation of his home deprived him of opportunities of mixing with other children frequently. His parents made him play nurse-maid to his younger sister, and when other boys made fun of him he became more aloof and introspective. He was sensitive to public criticism, and for this reason resented correction in class, and was very conscious of the slight speech defect produced by his split palate. Exaggerated facial gestures and other nervous mannerisms revealed the state of tension within. His extreme youthfulness made treatment difficult, because it was impossible to get rid of his immaturity when compared with the other members of the class. The tension was relieved to some extent when he became a member of the school under-14 soccer and cricket XI's.

In order to satisfy his self-esteem, he developed peculiar hobbies—moulding in lead, and collecting the skeletons of birds and animals. He overdid his pride in his intelligence, and at times was, therefore, an unpleasant companion. Later he gained some notoriety for his satiric sayings and writings.

Boys of this kind are always difficult to fit into a school

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organization. If they are advanced according to their scholastic ability, they tend to develop emotional difficulties; if they are retarded so that they are with boys of the same physique and emotional maturity, they tend to get into mischief because they are not kept sufficiently busy. This boy would probably have been more balanced in outlook if he had been held back a year and given a number of individual projects to keep him occupied.

This example shows how it is possible to use a record card (1) for selecting children for the different streams in a grammar school, (2) instead of the School Certificate examination, and (3) in deciding a boy's future occupation.

The boy is good all round, and would do well at either arts or science, but, from a consideration of his special aptitude and his attainment scores, it appears that he would be more successful on the arts side. There is no need for an examination to show that he is a boy of outstanding ability in English, French, and Maths., and that he is above average in Science, Social Studies, and Craftwork. In addition, the record shows—and this would not have been revealed by the School Certificate examination—that he has more than average mechanical aptitude and is equal to the average boy in manual dexterity and practical ability.

To an employer it would be possible to show, in addition, that he has certain weaknesses. His tendency to introversion and his less than normal sociability indicate that he would not do well as a teacher, or as a doctor, or in any other occupation where he would have to meet other people frequently. He seems fitted to make a scholar and research worker. It will be difficult to overcome the financial obstacles that stand in his way, but a generous local authority will find means of doing so.

## APPENDIX II

### SOME STANDARD TESTS

THE most useful collection of tests for the teacher is probably that in Sir Cyril Burt's "Handbook of Tests for Use in Schools" (Staples, 1947). Revised forms of these tests may be found in the second edition of the same author's "Mental and Scholastic Tests" (Staples, 1947) and, as revised by Dr. P. E. Vernon, in Volume XII of the publications of the Scottish Council of Research in Education (University of London Press, Ltd., 1940). Up-to-date tests in English subjects may be found in Professor F. Schonell's "Backwardness in the Basic Subjects" (Oliver & Boyd, 1942) and in Dr. A. F. Watts' "The Language and Mental Development of Children" (Harrap, 1944). These two excellent books deserve to be closely studied by all teachers.

The most widely used individual test of intelligence is that described by Mr. L. M. Terman and Miss M. A. Merrill in "Measuring Intelligence" (Harrap, 1937).

Below is given a short list of tests which have been found useful by teachers. A comprehensive and classified list is given by Dr. P. E. Vernon on pp. 198-209 of "The Measurement of Abilities" (University of London Press, Ltd., 1949).

<i>Author.</i>	<i>Title.</i>	<i>Age.</i>	<i>Publishers.</i>
Alexander.	Performance Scale	8 18	Nelson.
	Tharnt Mental Tests (Arithmetic, English and School Aptitudes).	10½ 12½	University of London Press.
	Junior School Grading Test	4½ 11½	" " "
Ballard.	Chelsea Mental Tests (Algebra, English Construction, English Comprehension, Geography, History).		" " "
	The New Examiner Tests.		" " "
	Columbian Tests of Intelligence.		" " "

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<i>Author.</i>	<i>Title.</i>	<i>Age.</i>	<i>Publishers.</i>
Burt.	Northumberland Standardized Tests (Arithmetic, English, Intelligence).	7½-14½	University of London Press.
Cattell.	Group & Individual Intelligence Tests. " F " Test.	8-11 & 11-15 9 and upwards	Harrap. University of London Press.
Earle.	Duplex Ability Tests.	10-14	Harrap.
Mellone.	Moray House Picture Intelligence Test.	6½-8½	University of London Press.
Nation ' Institute of Industrial Psychology.	Group Tests.	10½-16½	
Otis.	Group Intelligence Tests.	5-8 8-12	Harrap.
Richardson.	Simplex Intelligence Scales.	7-14 11-15	"
Schonell.	Diagnostic Tests (English & Arithmetic). Essential Tests (English & Arithmetical).	7-15 7-15	Oliver & Boyd, Edinburgh. " " "
Schonell & Adams.	The Essential Intelligence Test.	7-11	" " "
Sleight.	Non-Verbal Intelligence Test.	6-10	Harrap.
Terman.	Group Test of Mental Ability.	Inter. and Advanced.	"
Tomlinson.	" Northern " Test of Educability. " West Riding " Tests of Mental Ability.	10-11 10-12	University of London Press. " " "



# APPENDIX III

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	1935	How the Mind Works	Allen & Unwin
	1937	The Subnormal Mind	Oxford University Press.
	1945	The Young Delinquent.	University of London Press.
2nd Ed.	1947	The Backward Child	" " "
2nd Ed.	1947	Mental and Scholastic Tests.	Staples.
Cameron, H. C. (5th Edition)	1946	The Nervous Child.	Oxford University Press.
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Frankenburgh, M. S.	1946	Common Sense in the Nursery.	Penguin.

# APPENDIX III

<i>Author</i>	<i>Date</i>	<i>Title</i>	<i>Publisher</i>
Garrett, H. I.	1937	Statistics in Psychology and Education	Longmans, Green
Gesell, A.	1925	The Mental Growth of the First School Child	Macmillan, New York.
Glover, L.	1940	The Psychology of Fear and Courage	Penguin
Goodenough, I. I.	1926	Measurement of Intelligence by Drawing	Harrap
Gordon, K. G.	1926	Personality	Routledge & Kegan Paul
Hall, M. B.	1917	Psychiatric Examination of the School Child	Arnold
Hahn, E. J.	1943	Stuttering: Scientific Theories and Therapies	Stanford University Press, California Oxford U.P.
Himley, H. R. (Editor)	1927	The Educational Guidance of the School Child	Evans
Hutog, E. A. Rhodes, E. C.	1929	An Examination of Examinations	Macmillan
Hunsbello, E. J.	1917	Congenital Word Blindness	H. K. Lewis
Hollingworth, H. J.	1919	Vocational Psychology and Character Analysis	Appleton
Hollingsworth, L. S.	1916	Gifted Children: Their Nature and Nurture	Macmillan, New York
Home, A. School Council of Great Britain (Compiled by)	1936	Advances in Understanding the Child	London
Hunt, J. J. A. & Smith P.	1933	Advances in Understanding the Adolescent	London
Hunt, J. M. V. (Editor)	1933	Teacher's Guide to Intelligence and Other Psychological Testings	Evans
Hutcheon, Alice M.	1944	Personality and the Behaviour Disorders	Ronald Press Co. New York 2 volumes <b>New</b>
	1946	The Child and His Problems	Williams & Norgate
	1947	Motives of Conduct in Children	Jurrold
Isaacs, Susan	1930	Intellectual Growth in Young Children	Routledge & Kegan Paul London Harcourt Brace, New York
	1942	The Nursery Year	Routledge & Kegan Paul
	1943	Social Development in Children	Routledge & Kegan Paul, London Harcourt Brace, New York
	1947	The Educational Guidance of the School Child	Evans
James, W. Jones, C. G.	1901	The Principles of Psychology	Macmillan
	1929	Psychological Types	Routledge & Kegan Paul, London Harcourt Brace, New York
Kelley, T. I. Knutik, K.	1944	Statistical Method	Macmillan
	1943	Intelligence and Intelligence Tests	Methuen, London
Kohler, W.	1930	Gestalt Psychology	Bell
Lownfield, M.	1949	Play in Childhood	Victor Gollancz
Macrae, A.	1942	Talents and Temperaments	Nisbet
McDougal, W.	1943	An Outline of Psychology	Methuen
	1946	An Outline of Abnormal Psychology	"
McDougal, K. J. (2nd Edition)	1943	Same Psychology	John Murray
Metcalf, D.	1946	Bringing up Children	Falst Press
Miller, L. (Editor)	1937	The Growing Child and its Problems	Routledge & Kegan Paul

# EDUCATIONAL DEVELOPMENT OF CHILDREN

<i>Author.</i>	<i>Date.</i>	<i>Title.</i>	<i>Publisher.</i>
Ministry of Education.	1947	Special Educational Treatment.	H.M. Stationery Office.
Monroe, Marian.	1932	Children Who Cannot Read.	Chicago University Press.
Murchison, C. (Editor, 2nd Edition).	1933	A Handbook of Child Psychology.	Oxford University Press.
Norwood Report.	1941	Curriculum and Examination in Secondary Schools.	H.M. Stationery Office.
Nunn, T. P. (2nd Edition).	1946	Education: Its Data and First Principles.	Arnold.
Oakley, C. A. & Macrae, A.	1937	Handbook of Vocational Guidance.	University of London Press.
Oliver, R. A. C.	1946	Research in Education.	Allen & Unwin.
Oliver, R. A. C. & Field, H. E.	1937	The Educational Guidance of the School Child.	Evans.
Orton, S. T.	1937	Reading, Writing and Speech Problems in Children.	Chapman & Hall.
Piaget, J.	1926	The Language and Thought of the Child.	Routledge & Kegan Paul, London: Harcourt Brace, New York.
	1928	Judgment and Reasoning in the Child.	Harcourt Brace, New York.
Pintner, R. & Paterson, D.	1917	Performance Tests.	Appleton, New York.
Rees, J. R.	1929	The Health of the Mind.	Faber & Faber.
Ross, T. A.	1924	The Common Neurosis.	Arnold.
Rumsey, H. St. John.	1937	Your Stammer and How to Correct It.	Frederick Muller.
Schonell, F. J.		The Diagnosis of Individual Difficulties in Arithmetic.	Oliver & Boyd, Edinburgh.
		Diagnostic and Remedial Teaching in English.	" " "
Schonell, F. J.	1942	Backwardness in the Basic Subjects.	" " "
Sheldon, W. (5th Edition).	1946	Diseases of Infancy and Childhood.	Churchill.
Spearman, C.	1923	The Nature of Intelligence.	Macmillan.
	1927	Psychology Down the Ages.	"
	1927	The Abilities of Man.	"
Stern, W.	1930	Psychology of Early Childhood.	Allen & Unwin, London: Holt, New York.
Strong, E. K., Jr.	1943	Vocational Interests of Men & Women	Stanford Univ. Press and Oxford Univ. Press
Stutsman, R.	1931	Mental Measurement of Pre-School Children.	Harrap.
Terman, L. M.	1919	The Measurement of Intelligence.	"
Terman, L. M. & Merrill, M. A.	1937	Measuring Intelligence.	"
Thom, D. A.	1927	Everyday Problems of the Everyday Child.	Appleton.
Thomson, Sir Godfrey (2nd Edition.)	1945	The Factorial Analysis of Human Ability.	University of London Press.
	1932	Instinct, Intelligence & Character.	Allen & Unwin.
Thorndike, E. L.	1935	Adult Interests.	Macmillan.
Thorndike, E. L., et al.	1927	The Measurement of Intelligence.	Teachers College, Columbia University, N.Y.
Thouless, R. H.	1937	General and Social Psychology.	University Tutorial Press.
Valentine, C. W.	1940	The Difficult Child and the Problem of Discipline.	Methuen.

# APPENDIX III

<i>Author.</i>	<i>Date.</i>	<i>Title.</i>	<i>Publisher.</i>
Valentine, C. W.	1942	The Psychology of Early Childhood.	Methuen.
Valentine, C. W. & Emmett, W.	1932	The Reliability of Examinations.	University of London Press.
Vernon, P. E.	1935	Tests of Temperament & Character.	Evan.
	1935	Tests in Aesthetics.	
	1938	The Standardisation of a Graded Word Reading Test.	University of London Press.
	1939	The Assessment of Psychological Qualities by Verbal Methods.	H M. Stationery Office.
	1940	The Measurement of Abilities	University of London Press.
Wallin, J. E. W.	1935	Personality Maladjustments and Mental Hygiene.	McGraw-Hill Publishing Co.
Watts, A. F.	1944	The Language & Mental Development of Children.	Harrap.
White, W.	1948	Psychology in Living.	Jurrolds.
Woodworth, R. S.	1935	Contemporary Schools of Psychology.	Methuen.
	1937	Gestalt Psychology.	Ronald Press Co., New York
	1939	Experimental Psychology.	Methuen.
(9th Edition )	1932	Psychology.	"

# APPENDIX IV

## LOG ARITHMS

	0 1 2 3 4					5 6 7 8 9					Mean Difference									
10	0000	0043	0096	0159	0170	0212	0253	0294	0334	0374	4 8 12 17	21	25	29	33	37				
11	0414	04 3	047	0 1	0 6	0607	064	0 82	0711	07	4 8 11 1	12				34				
12	072	08 9	0864	0999	0934	0963	1004	10 1	1 2	1136	3 7 10 14	17	1	4	9	31				
13	1159	1173	1206	1239	1271	1303	1333	1367	1399	1430	3 6 10 1	16	19	23	26	29				
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3 6 9 1	5	13	1	24	27				
15	1 61	170	1819	1847	18	19 3	1931	19 9	1987	2 14	3 6 8 11	4	17			2				
16	41	2068	2 5	21 2	214	2 5	2 01	7	3	279	3 5 8 11				1	21	24			
17	304	2300	2333	2360	240	2430	24 3	2490	2504	2 29	2 5 7 1	12	15	17	2	22				
18	2 53	2577	2601	2625	2648	2672	2695	2718	2742	2766	2 5 7	12	14	1	1	21				
19	2 68	2610	2 33	2 6	2672	00 2	294	2 67	282		4 7	11	1		1					
20	3310	30 2	3 40	3 3		3118	1 3	3131	32 1	2 4 6		1	1	1	1	1				
21	3222	3243	3263	3284	3304	3324	3343	3363	3385	3404	2 4 6 8	10	1	14	1	1				
22	3424	3444	3464	3483	3502	3522	3541	3 60	3579	3598	2 4 6 8			12	14	15	17			
23	3617	36 6	3655	3674	3693	3711	3729	3747	3 66	3784	2 4 6 7				13	1	17			
24	3802	3820	3838	38 6	3874	3892	3 39	39 3	394	3 3	4 5			11	1	14	16			
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4 3	2 3	7	13	12	14	15				
26	41 0	4166	4183	4200	4216	42 2	4249	4265	4281	4298	2 3 5	7		10	11	13	15			
27	4314	4330	4 46	4 62	4 78	4 33	44 9	44 5	4440	44 6	2 3 5	6		9	11	13	14			
28	4472	44 7	4 32	4 18	4 3	4 48	4 64	4 79	4 34	46	2 3 5	6		8	9	11	14			
29	4624	4639	4654	4669	468	4638	4713	4728	4742	47 7	1 3 4 6			7	9	10	12	13		
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1 3 4 6			7	9	11	11	1		
31	4914	4928	4942	49 5	4969	4983	4997	011	5024	0 8	1 3 4 6			7	8	11	13	14		
32	0 1	5035	5 79	092	51	113	1 2	1145	51 9	117	1 3 4			7	8	9	11	12		
33	183	5198	5211	5224	52 7	2 0	2 3	276	5283	5302	1 3 4			6	8	9	1	1		
34	315	5328	5340	3 3	5366	5 78	91	5403	5416	54	1 3 4			6	8	9	11	11		
35	441	4 3	46	5478	496	2	14	7		1	1 2 4			6	7	9	11	11		
36	63	7	57	5599	611	6 3	6	647	6 3	67	1 2 4			6	7	1	11			
37	5682	5694	5703	5717	572	74	72	63	573	578	1 2 3	5		6	7	8	9	10		
38	5798	5809	5821	5832	584	5855	5866	5877	5888	5899	1 2 3	5		6	7	8	9	10		
39	911	5922	5933	5944	59	596	5977	5988	5999	601	1 2 3 4			7	9	10				
40	6021	6 1	6 42	60 3	6064	6 63	6 6	6 67	6 07	611	1 2 3 4			5	6			1		
41	618	6138	6149	6160	6170	6180	6191	6201	6212	622	1 2 3 4			5	6	7	8	9		
42	62 2	6243	6253	6263	6274	6284	6294	6304	6314	632	1 2 3 4			5	6	7	8	9		
43	63 6	634	6 5	6 53	6	6 63	6 6	64 5	6415	64	1 2 3 4			5	6	7	8	9		
44	64	6444	64 4	6464	64 4	64 4	6493	6 33	6513	6 22	1 2 3 4			5	6	7	8	9		
45	6 2	6 42	6531	6561	6 71	6580	6 63	6 69	6609	6618	1 2 3 4			5	6	7	8	9		
46	6628	66 7	6646	6656	6667	6677	6684	6693	6702	6712	1 2 3 4			5	6	7	7	8		
47	6721	6731	67 9	6749	676	67 7	67 8	67 8	6734	6	1 2 3 4			5	5	6	7	8		
48	6812	6 1	6 16	68 9	684	68 7	6 6	685	68 4	68	1 2 3 4			4	5	6	7	8		
49	6902	69 1	6 23	6928	69 7	6946	69 9	6 64	6972	6981	1 2 3 4			4	5	6	7	8		
50	6990	6998	7007	7016	7024	7033	7042	70 0	70 9	7067	1 2 3 3			4	5	6	7	8		
51	7076	7084	7 93	7101	7110	71 3	712	135	7143	71	1 2 3			4	5	6	7	8		
52	7160	7168	7177	7185	719	7 2	7 2 10	7218	7226	723	1 2 2 3			4	5	6	7	8		
53	7243	7251	7259	7267	727	7284	7292	7300	7308	7316	1 2 2 3			4	5	6	6	7		
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1 2 2 3			4	5	6	6	7		
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	

# APPENDIX IV

## LOGARITHMS

											Mean Differences															
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9							
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7							
56	7482	7490	7497	7505	7513	7521	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7							
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7							
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7							
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7							
60	7782	7789	7796	7803	7811	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	7							
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	7							
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	4	4	5	6	7							
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	4	4	5	6	7							
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	4	4	5	6	7							
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	4	4	5	6	7							
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	4	4	5	6	7							
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	4	4	5	6	7							
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	4	4	5	6	7							
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8444	1	1	2	3	4	4	5	6	7							
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	3	4	4	5	6	7							
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	3	4	4	5	6	7							
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	3	4	4	5	6	7							
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8687	1	1	2	3	4	4	5	6	7							
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	3	4	4	5	6	7							
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8803	1	1	2	3	4	4	5	6	7							
76	8809	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	3	4	4	5	6	7							
77	8865	8871	8876	8882	8887	8893	8898	8904	8909	8914	1	1	2	3	4	4	5	6	7							
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	3	4	4	5	6	7							
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	3	4	4	5	6	7							
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	3	4	4	5	6	7							
81	9090	9095	9100	9106	9111	9117	9122	9128	9133	9138	1	1	2	3	4	4	5	6	7							
82	9148	9153	9159	9164	9169	9175	9180	9186	9191	9196	1	1	2	3	4	4	5	6	7							
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9237	1	1	2	3	4	4	5	6	7							
84	9243	9248	9253	9258	9263	9268	9273	9278	9283	9288	1	1	2	3	4	4	5	6	7							
85	9293	9298	9303	9308	9313	9318	9323	9328	9333	9338	1	1	2	3	4	4	5	6	7							
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	3	4	4	5	6	7							
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4							
88	9444	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4							
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4							
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4							
91	9592	9595	9600	9605	9609	9614	9619	9624	9629	9633	0	1	1	2	2	3	3	4	4							
92	9643	9647	9652	9657	9662	9666	9671	9676	9681	9686	0	1	1	2	2	3	3	4	4							
93	9693	9697	9702	9707	9712	9716	9721	9726	9731	9736	0	1	1	2	2	3	3	4	4							
94	9741	9746	9751	9756	9761	9765	9770	9775	9780	9785	0	1	1	2	2	3	3	4	4							
95	9777	9782	9786	9791	9796	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4							
96	9823	9827	9832	9837	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4							
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4							
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4							
99	9956	9961	9965	9970	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	4	4							
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9							

## APPENDIX V

## SQUARES

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
10	1000	1020	1040	1061	1082	1103	1124	1145	1166	1188	2	4	6	8	10	13	15	17	19
11	1210	1232	1254	1277	1300	1323	1346	1369	1392	1416	2	5	7	9	11	14	16	18	21
12	1440	1464	1488	1513	1538	1563	1588	1613	1638	1664	2	5	7	10	12	15	17	20	22
13	1690	1716	1742	1769	1796	1823	1850	1877	1904	1932	3	5	8	11	13	16	19	22	24
14	1960	1988	2016	2045	2074	2103	2132	2161	2190	2220	3	6	9	12	14	17	20	23	26
15	2250	2280	2310	2341	2372	2403	2434	2465	2496	2528	3	6	9	12	15	19	22	25	28
16	2560	2592	2624	2657	2690	2723	2756	2789	2822	2856	3	7	10	13	16	20	23	26	30
17	2890	2924	2958	2993	3028	3063	3098	3133	3168	3204	3	7	10	14	17	21	24	28	31
18	3240	3276	3312	3349	3386	3423	3460	3497	3534	3572	4	7	11	15	18	22	26	30	33
19	3610	3648	3686	3725	3764	3803	3842	3881	3920	3960	4	8	12	16	19	23	27	31	35
20	4000	4040	4080	4121	4162	4203	4244	4285	4326	4368	4	8	12	16	20	24	29	33	37
21	4410	4452	4494	4537	4580	4623	4666	4709	4752	4796	4	9	13	17	21	26	30	34	39
22	4840	4884	4928	4973	5018	5063	5108	5153	5198	5244	4	9	13	18	22	27	31	36	40
23	5290	5336	5382	5429	5476	5523	5570	5617	5664	5712	5	9	14	19	23	28	33	38	42
24	5760	5808	5856	5905	5954	6003	6052	6101	6150	6200	5	10	15	20	24	29	34	39	44
25	6250	6300	6350	6401	6452	6503	6554	6605	6656	6708	5	10	15	20	25	31	36	41	46
26	6760	6812	6864	6917	6970	7023	7076	7129	7182	7236	5	11	16	21	26	32	37	42	48
27	7290	7344	7398	7453	7508	7563	7618	7673	7728	7784	5	11	16	22	27	33	38	44	49
28	7840	7896	7952	8009	8066	8123	8180	8237	8294	8352	6	11	17	23	28	34	40	46	51
29	8410	8468	8526	8585	8644	8703	8762	8821	8880	8940	6	12	18	24	29	35	41	47	53
30	9000	9060	9120	9181	9242	9303	9364	9425	9486	9548	6	12	18	24	30	37	43	49	55
31	9610	9672	9734	9797	9860	9923	9986	1005	1011	1018	6	13	19	25	31	38	44	50	57
32	1024	1030	1037	1043	1050	1056	1063	1069	1076	1082	1	1	2	3	3	4	5	5	6
33	1089	1096	1102	1109	1116	1122	1129	1136	1142	1149	1	1	2	3	3	4	5	5	6
34	1156	1163	1170	1176	1183	1190	1197	1204	1211	1218	1	1	2	3	3	4	5	6	6
35	1225	1232	1239	1246	1253	1260	1267	1274	1282	1289	1	1	2	3	4	4	5	6	6
36	1296	1303	1310	1318	1325	1332	1340	1347	1354	1362	1	1	2	3	4	4	5	6	7
37	1369	1376	1384	1391	1399	1406	1414	1421	1429	1436	1	2	2	3	4	5	5	6	7
38	1444	1452	1459	1467	1475	1482	1490	1498	1505	1513	1	2	2	3	4	5	5	6	7
39	1521	1529	1537	1544	1552	1560	1568	1576	1584	1592	1	2	2	3	4	5	6	6	7
40	1600	1608	1616	1624	1632	1640	1648	1656	1665	1673	1	2	2	3	4	5	6	6	7
41	1681	1689	1697	1706	1714	1722	1731	1739	1747	1756	1	2	2	3	4	5	6	7	7
42	1764	1772	1781	1789	1798	1806	1815	1823	1832	1840	1	2	3	3	4	5	6	7	8
43	1849	1858	1866	1875	1884	1892	1901	1910	1918	1927	1	2	3	3	4	5	6	7	8
44	1936	1945	1954	1962	1971	1980	1989	1998	2007	2016	1	2	3	4	4	5	6	7	8
45	2025	2034	2043	2052	2061	2070	2079	2088	2098	2107	1	2	3	4	5	5	6	7	8
46	2116	2125	2134	2144	2153	2162	2172	2181	2190	2200	1	2	3	4	5	6	7	7	8
47	2209	2218	2228	2237	2247	2256	2266	2275	2285	2294	1	2	3	4	5	6	7	8	9
48	2304	2314	2323	2333	2343	2352	2362	2372	2381	2391	1	2	3	4	5	6	7	8	9
49	2401	2411	2421	2430	2440	2450	2460	2470	2480	2490	1	2	3	4	5	6	7	8	9
50	2500	2510	2520	2530	2540	2550	2560	2570	2581	2591	1	2	3	4	5	6	7	8	9
51	2601	2611	2621	2632	2642	2652	2663	2673	2683	2694	1	2	3	4	5	6	7	8	9
52	2704	2714	2725	2735	2746	2756	2767	2777	2788	2798	1	2	3	4	5	6	7	8	9
53	2809	2820	2830	2841	2852	2862	2873	2884	2894	2905	1	2	3	4	5	6	7	9	10
54	2916	2927	2938	2948	2959	2970	2981	2992	3003	3014	1	2	3	4	5	7	8	9	10

# APPENDIX V

## SQUARES

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
55	3025	3036	3047	3058	3069	3080	3091	3102	3114	3125	1	2	3	4	5	6	7	8	9
56	3136	3147	3158	3170	3181	3192	3204	3215	3226	3238	1	2	3	4	5	6	7	8	9
57	3249	3260	3272	3283	3295	3306	3318	3329	3341	3352	1	2	3	4	5	6	7	8	9
58	3364	3376	3387	3399	3411	3422	3434	3446	3457	3469	1	2	4	5	6	7	8	9	11
59	3481	3493	3505	3516	3528	3540	3552	3564	3576	3588	1	2	4	5	6	7	8	10	11
60	3600	3612	3624	3636	3648	3660	3672	3684	3697	3709	1	2	4	5	6	7	8	10	11
61	3721	3733	3745	3758	3770	3782	3795	3807	3819	3832	1	2	4	5	6	7	9	10	11
62	3844	3856	3869	3881	3894	3906	3919	3931	3944	3956	1	3	4	5	6	7	9	10	11
63	3969	3982	3994	4007	4020	4032	4045	4058	4070	4083	1	3	4	5	6	8	9	10	11
64	4096	4109	4122	4134	4147	4160	4173	4186	4199	4212	1	3	4	5	6	8	9	10	12
65	4225	4238	4251	4264	4277	4290	4303	4316	4330	4343	1	3	4	5	7	8	9	10	12
66	4356	4369	4382	4396	4409	4422	4436	4449	4462	4476	1	3	4	5	7	8	9	11	12
67	4489	4502	4516	4529	4543	4556	4570	4583	4597	4610	1	3	4	5	7	8	9	11	12
68	4624	4638	4651	4665	4679	4692	4706	4720	4733	4747	1	3	4	5	7	8	10	11	12
69	4761	4775	4789	4802	4816	4830	4844	4858	4872	4886	1	3	4	6	7	8	10	11	13
70	4900	4914	4928	4942	4956	4970	4984	4998	5013	5027	1	3	4	6	7	8	10	11	13
71	5041	5055	5069	5084	5098	5112	5127	5141	5155	5170	1	3	4	6	7	9	10	11	13
72	5184	5198	5213	5227	5242	5256	5271	5285	5300	5314	1	3	4	6	7	9	10	12	13
73	5329	5344	5358	5373	5388	5402	5417	5432	5446	5461	1	3	4	6	7	9	10	12	13
74	5476	5491	5506	5520	5535	5550	5565	5580	5595	5610	1	3	4	6	7	9	10	12	13
75	5625	5640	5655	5670	5685	5700	5715	5730	5746	5761	2	3	5	6	8	9	11	12	14
76	5776	5791	5806	5822	5837	5852	5868	5883	5898	5914	2	3	5	6	8	9	11	12	14
77	5929	5944	5960	5975	5991	6006	6022	6037	6053	6068	2	3	5	6	8	9	11	12	14
78	6084	6100	6115	6131	6147	6162	6178	6194	6209	6225	2	3	5	6	8	9	11	13	14
79	6241	6257	6273	6288	6304	6320	6336	6352	6368	6384	2	3	5	6	8	10	11	13	14
80	6400	6416	6432	6448	6464	6480	6496	6512	6529	6545	2	3	5	6	8	10	11	13	14
81	6561	6577	6593	6610	6626	6642	6659	6675	6691	6708	2	3	5	7	8	10	11	13	15
82	6724	6740	6757	6773	6790	6806	6823	6839	6856	6872	2	3	5	7	8	10	12	13	15
83	6889	6906	6922	6939	6956	6972	6989	7006	7022	7039	2	3	5	7	8	10	12	13	15
84	7056	7073	7090	7106	7123	7140	7157	7174	7191	7208	2	3	5	7	8	10	12	14	15
85	7225	7242	7259	7276	7293	7310	7327	7344	7362	7379	2	3	5	7	9	10	12	14	15
86	7396	7413	7430	7448	7465	7482	7500	7517	7534	7552	2	3	5	7	9	11	12	14	16
87	7569	7586	7604	7621	7639	7656	7674	7691	7709	7726	2	4	5	7	9	10	12	14	16
88	7744	7762	7779	7797	7815	7832	7850	7868	7885	7903	2	4	5	7	9	11	12	14	16
89	7921	7939	7957	7974	7992	8010	8028	8046	8064	8082	2	4	5	7	9	11	13	14	16
90	8100	8118	8136	8154	8172	8190	8208	8226	8245	8263	2	4	5	7	9	11	13	14	16
91	8281	8299	8317	8335	8353	8372	8391	8409	8427	8446	2	4	5	7	9	11	13	15	16
92	8464	8482	8501	8519	8538	8556	8575	8593	8612	8630	2	4	6	7	9	11	13	15	17
93	8649	8668	8686	8705	8724	8742	8761	8780	8798	8817	2	4	6	7	9	11	13	15	17
94	8836	8855	8874	8892	8911	8930	8949	8968	8987	9006	2	4	6	8	9	11	13	15	17
95	9025	9044	9063	9082	9101	9120	9139	9158	9177	9197	2	4	6	8	10	11	13	15	17
96	9216	9235	9254	9274	9293	9312	9332	9351	9370	9390	2	4	6	8	10	12	14	15	17
97	9409	9428	9448	9467	9487	9506	9526	9545	9565	9584	2	4	6	8	10	12	14	16	18
98	9604	9624	9644	9663	9683	9702	9722	9742	9761	9781	2	4	6	8	10	12	14	16	18
99	9801	9821	9841	9860	9880	9900	9920	9940	9960	9980	2	4	6	8	10	12	14	16	18



# EDUCATIONAL DEVELOPMENT OF CHILDREN

## SQUARE ROOTS

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
10	1000	1005	1010	1015	1020	1025	1030	1034	1039	1044	0 1 1	2 2 3	3 4 4
11	1049	1 4	1 8	1 3	1 4	1 72	1077	1082	1086	1 1	0 1 1	2 2 3	3 4 4
12	10 5	11 00	11 10	11 1 3	1 14	1119	1122	1127	1131	1136	0 1 1	2 2 3	3 4 4
13	1140	1145	1149	1153	11 8	1162	1166	1170	1175	1179	0 1 1	2 2 3	3 3 4
14	1183	1187	1192	1196	1200	1204	1208	1212	1217	1221	0 1 1	2 2 2	3 3 4
15	1225	1229	12 3	12 17	1 41	1245	1 4 3	12 3	12 7	1 1	0 1 1	2 2 2	3 3 4
16	1260	1265	1273	1277	12 1	12 5	12 9	1292	1 26	13	0 1 1	2 2 2	3 3 4
17	1304	1308	1311	1315	1319	1323	1327	1330	1334	1338	0 1 1	2 2 2	3 3 3
18	1342	1347	1349	1353	1356	1 60	1364	1367	1371	1	0 1 1	1 2 2	3 3 3
19	1 78	1 2	1 96	1 89	1 3	1 6	1470	1404	1437	1411	0 1 1	1 2 2	3 3 3
20	1414	14 8	1421	14	14 8	1432	14 5	1439	1442	144	0 1 1	1 2 2	3 3 3
21	1449	14 3	1456	1459	1463	1466	1470	1473	1476	148	0 1 1	1 2 2	3 3 3
22	1483	1487	1490	1493	1497	1500	1503	1507	1510	1513	0 1 1	1 2 2	2 3 3
23	1517	1 3	1 5	1526	1 37	1 3	1	151	1 43	151	0 1 1	1 2 2	2 3 3
24	1549	15 2	1 6	1 7	1 62	1 5	1 9	1 72	1 75	157	0 1 1	1 2 2	2 3 3
25	1581	1584	1587	1591	1594	1597	1600	1603	1606	1609	0 1 1	1 2 2	2 3 3
26	1612	1616	1619	1622	1625	1628	1631	1634	1637	1640	0 1 1	1 2 2	2 2 3
27	1643	1645	1 42	16 2	16	1 9	1641	16 4	1667	1 7	0 1 1	1 2 2	2 2 3
28	1673	1676	1679	1682	1685	16 9	16 1	16 4	16 7	1 7	0 1 1	1 1 2	2 2 3
29	1703	1706	1707	1712	1715	1718	1720	1723	1726	1727	0 1 1	1 1 2	2 2 3
30	1732	1735	1738	1741	1744	1746	1749	1752	1755	17 8	0 1 1	1 1 2	2 2 3
31	17 1	17 4	1766	1769	1772	17	1779	1 3	17 3	1 3	0 1 1	1 1 2	2 2 3
32	1739	1742	1744	1747	1750	1 3	1 6	17 8	1811	1 14	0 1 1	1 1 2	2 2 2
33	1817	1819	1822	1825	1828	1830	1833	1836	1838	1841	0 1 1	1 1 2	2 2 2
34	1844	1847	1849	1852	1855	1857	1860	1863	1865	1868	0 1 1	1 1 2	2 2 2
35	1871	1 73	1 76	1879	1881	1 4	18 7	18 9	18 9	18 9	0 1 1	1 1 2	2 2 2
36	18 7	1 3	1 3	1 3	1 9	1910	1913	1916	1918	1 1	0 1 1	1 1 2	2 2 2
37	1924	1925	1929	1931	1934	1936	1939	1942	1944	1947	0 1 1	1 1 2	2 2 2
38	1949	1952	1954	1957	1960	1962	1965	1967	1970	1972	0 1 1	1 1 2	2 2 2
39	1975	1977	19 9	1982	19 5	19 7	1990	1992	19 9	1 7	0 1 1	1 1 2	2 2 2
40	2 3	20 2	2035	2 37	2 13	2 12	2 15	2 17	2 20	2	0 0 1	1 1 1	2 2 2
41	2040	2027	2030	2032	2035	20 7	2040	2042	2045	2 47	0 0 1	1 1 1	2 2 2
42	2049	2 52	2054	2057	2059	2062	2064	2066	2069	2 1	0 0 1	1 1 1	2 2 2
43	2074	2 7	2078	2 1	2 3	2 5	2 8	2 30	2 33	2 3	0 0 1	1 1 1	2 2 2
44	2098	21 0	2102	21 5	21 7	2110	2112	2114	2117	2119	0 0 1	1 1 1	2 2 2
45	2121	2124	2126	2128	2131	2133	2135	2138	2140	2142	0 0 1	1 1 1	2 2 2
46	2145	2147	2149	2152	2154	2156	2159	2161	2163	2166	0 0 1	1 1 1	2 2 2
47	2168	2170	2173	2175	2 77	2179	2 2	2184	2186	21 9	0 0 1	1 1 1	2 2 2
48	2191	2193	2195	2198	2 3	22 2	2 5	22 7	22 9	2211	0 0 1	1 1 1	2 2 2
49	2214	2216	2218	2220	2223	2225	2227	2229	2232	22 4	0 0 1	1 1 1	2 2 2
50	2236	2238	2241	2243	2245	2247	2249	2252	2254	22 5	0 0 1	1 1 1	2 2 2
51	22 8	22 1	22 3	22 7	22 7	22 9	2272	22 4	2 7	2274	0 0 1	1 1 1	2 2 2
52	2280	2283	2 3	22 7	22 9	2291	2 33	2296	22 8	22 9	0 0 1	1 1 1	2 2 2
53	2302	2304	2307	2309	2311	2313	2315	2317	2319	2322	0 0 1	1 1 1	2 2 2
54	2324	2326	2328	2330	2 32	2335	2337	2339	2341	2343	0 0 1	1 1 1	1 2 2

Find the first significant figure and the position of the decimal point by inspection

# APPENDIX V

## SQUARE ROOTS

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
55	234	2347	2 49	2 52	2 4	2 6	2350	2 53	2 57	2 64	0 0 1	1 1 1	1 2 2
56	235	2 59	2 51	2 53	2 5	2 7	2 59	2 61	2 64	2 71	0 0 1	1 1 1	1 2 2
57	236	2 60	2 52	2 54	2 6	2 8	2 60	2 62	2 65	2 72	0 0 1	1 1 1	1 2 2
58	237	2 61	2 53	2 55	2 7	2 9	2 61	2 63	2 66	2 73	0 0 1	1 1 1	1 2 2
59	238	2 62	2 54	2 56	2 8	2 10	2 62	2 64	2 67	2 74	0 0 1	1 1 1	1 2 2
60	239	2 63	2 55	2 57	2 9	2 11	2 63	2 65	2 68	2 75	0 0 1	1 1 1	1 2 2
61	240	2 64	2 56	2 58	2 10	2 12	2 64	2 66	2 69	2 76	0 0 1	1 1 1	1 2 2
62	241	2 65	2 57	2 59	2 11	2 13	2 65	2 67	2 70	2 77	0 0 1	1 1 1	1 2 2
63	242	2 66	2 58	2 60	2 12	2 14	2 66	2 68	2 71	2 78	0 0 1	1 1 1	1 2 2
64	243	2 67	2 59	2 61	2 13	2 15	2 67	2 69	2 72	2 79	0 0 1	1 1 1	1 2 2
65	244	2 68	2 60	2 62	2 14	2 16	2 68	2 70	2 73	2 80	0 0 1	1 1 1	1 2 2
66	245	2 69	2 61	2 63	2 15	2 17	2 69	2 71	2 74	2 81	0 0 1	1 1 1	1 2 2
67	246	2 70	2 62	2 64	2 16	2 18	2 70	2 72	2 75	2 82	0 0 1	1 1 1	1 2 2
68	247	2 71	2 63	2 65	2 17	2 19	2 71	2 73	2 76	2 83	0 0 1	1 1 1	1 2 2
69	248	2 72	2 64	2 66	2 18	2 20	2 72	2 74	2 77	2 84	0 0 1	1 1 1	1 2 2
70	249	2 73	2 65	2 67	2 19	2 21	2 73	2 75	2 78	2 85	0 0 1	1 1 1	1 2 2
71	250	2 74	2 66	2 68	2 20	2 22	2 74	2 76	2 79	2 86	0 0 1	1 1 1	1 2 2
72	251	2 75	2 67	2 69	2 21	2 23	2 75	2 77	2 80	2 87	0 0 1	1 1 1	1 2 2
73	252	2 76	2 68	2 70	2 22	2 24	2 76	2 78	2 81	2 88	0 0 1	1 1 1	1 2 2
74	253	2 77	2 69	2 71	2 23	2 25	2 77	2 79	2 82	2 89	0 0 1	1 1 1	1 2 2
75	254	2 78	2 70	2 72	2 24	2 26	2 78	2 80	2 83	2 90	0 0 1	1 1 1	1 2 2
76	255	2 79	2 71	2 73	2 25	2 27	2 79	2 81	2 84	2 91	0 0 1	1 1 1	1 2 2
77	256	2 80	2 72	2 74	2 26	2 28	2 80	2 82	2 85	2 92	0 0 1	1 1 1	1 2 2
78	257	2 81	2 73	2 75	2 27	2 29	2 81	2 83	2 86	2 93	0 0 1	1 1 1	1 2 2
79	258	2 82	2 74	2 76	2 28	2 30	2 82	2 84	2 87	2 94	0 0 1	1 1 1	1 2 2
80	259	2 83	2 75	2 77	2 29	2 31	2 83	2 85	2 88	2 95	0 0 1	1 1 1	1 2 2
81	260	2 84	2 76	2 78	2 30	2 32	2 84	2 86	2 89	2 96	0 0 1	1 1 1	1 2 2
82	261	2 85	2 77	2 79	2 31	2 33	2 85	2 87	2 90	2 97	0 0 1	1 1 1	1 2 2
83	262	2 86	2 78	2 80	2 32	2 34	2 86	2 88	2 91	2 98	0 0 1	1 1 1	1 2 2
84	263	2 87	2 79	2 81	2 33	2 35	2 87	2 89	2 92	2 99	0 0 1	1 1 1	1 2 2
85	264	2 88	2 80	2 82	2 34	2 36	2 88	2 90	2 93	3 00	0 0 1	1 1 1	1 2 2
86	265	2 89	2 81	2 83	2 35	2 37	2 89	2 91	2 94	3 01	0 0 1	1 1 1	1 2 2
87	266	2 90	2 82	2 84	2 36	2 38	2 90	2 92	2 95	3 02	0 0 1	1 1 1	1 2 2
88	267	2 91	2 83	2 85	2 37	2 39	2 91	2 93	2 96	3 03	0 0 1	1 1 1	1 2 2
89	268	2 92	2 84	2 86	2 38	2 40	2 92	2 94	2 97	3 04	0 0 1	1 1 1	1 2 2
90	269	2 93	2 85	2 87	2 39	2 41	2 93	2 95	2 98	3 05	0 0 1	1 1 1	1 2 2
91	270	2 94	2 86	2 88	2 40	2 42	2 94	2 96	2 99	3 06	0 0 1	1 1 1	1 2 2
92	271	2 95	2 87	2 89	2 41	2 43	2 95	2 97	3 00	3 07	0 0 1	1 1 1	1 2 2
93	272	2 96	2 88	2 90	2 42	2 44	2 96	2 98	3 01	3 08	0 0 1	1 1 1	1 2 2
94	273	2 97	2 89	2 91	2 43	2 45	2 97	2 99	3 02	3 09	0 0 1	1 1 1	1 2 2
95	274	2 98	2 90	2 92	2 44	2 46	2 98	3 00	3 03	3 10	0 0 1	1 1 1	1 2 2
96	275	2 99	2 91	2 93	2 45	2 47	2 99	3 01	3 04	3 11	0 0 1	1 1 1	1 2 2
97	276	3 00	2 92	2 94	2 46	2 48	3 00	3 02	3 05	3 12	0 0 1	1 1 1	1 2 2
98	277	3 01	2 93	2 95	2 47	2 49	3 01	3 03	3 06	3 13	0 0 1	1 1 1	1 2 2
99	278	3 02	2 94	2 96	2 48	2 50	3 02	3 04	3 07	3 14	0 0 1	1 1 1	1 2 2

Find the first significant figure and the position of the decimal point by inspection

# EDUCATIONAL DEVELOPMENT OF CHILDREN

## SQUARE ROOTS

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
10	3162	3178	3194	3209	3225	3240	3256	3271	3286	3302	2 3 5	6 8 9	11 12 14
11	3317	3332	3347	3362	3376	3391	3406	3421	3435	3450	1 3 4	6 7 9	10 12 13
12	3464	3479	3493	3507	3521	3536	3550	3564	3578	3592	1 3 4	6 7 8	10 11 13
13	3606	3619	3633	3647	3661	3674	3688	3701	3715	3728	1 3 4	5 7 8	10 11 12
14	3742	3755	3768	3782	3795	3808	3821	3834	3847	3860	1 3 4	5 7 8	9 11 12
15	3873	3886	3899	3912	3924	3937	3950	3962	3975	3987	1 3 4	5 6 8	9 10 11
16	4000	4012	4025	4037	4050	4062	4074	4087	4099	4111	1 2 4	5 6 7	9 10 11
17	4123	4135	4147	4159	4171	4183	4195	4207	4219	4231	1 2 4	5 6 7	8 10 11
18	4243	4254	4266	4278	4290	4301	4313	4324	4336	4347	1 2 3	5 6 7	8 9 10
19	4359	4370	4382	4393	4405	4416	4427	4438	4450	4461	1 2 3	5 6 7	8 9 10
20	4472	4483	4494	4506	4517	4528	4539	4550	4561	4572	1 2 3	4 6 7	8 9 10
21	4583	4593	4604	4615	4626	4637	4648	4658	4669	4680	1 2 3	4 5 6	8 9 10
22	4690	4701	4712	4722	4733	4743	4754	4764	4775	4785	1 2 3	4 5 6	7 8 9
23	4796	4806	4817	4827	4837	4848	4858	4868	4879	4889	1 2 3	4 5 6	7 8 9
24	4899	4909	4919	4930	4940	4950	4960	4970	4980	4990	1 2 3	4 5 6	7 8 9
25	5000	5010	5020	5030	5040	5050	5060	5070	5079	5089	1 2 3	4 5 6	7 8 9
26	5099	5109	5119	5128	5138	5148	5158	5167	5177	5187	1 2 3	4 5 6	7 8 9
27	5196	5206	5215	5225	5235	5244	5254	5263	5273	5282	1 2 3	4 5 6	7 8 9
28	5292	5301	5310	5320	5329	5338	5348	5357	5367	5376	1 2 3	4 5 6	7 7 8
29	5385	5394	5404	5413	5422	5431	5441	5450	5459	5468	1 2 3	4 5 5	6 7 8
30	5477	5486	5495	5505	5514	5523	5532	5541	5550	5559	1 2 3	4 4 5	6 7 8
31	5568	5577	5586	5595	5604	5612	5621	5630	5639	5648	1 2 3	3 4 5	6 7 8
32	5657	5666	5675	5683	5692	5701	5710	5718	5727	5736	1 2 3	3 4 5	6 7 8
33	5745	5753	5762	5771	5779	5788	5797	5805	5814	5822	1 2 3	3 4 5	6 7 8
34	5831	5840	5848	5857	5865	5874	5882	5891	5899	5908	1 2 3	3 4 5	6 7 8
35	5916	5925	5933	5941	5950	5958	5967	5975	5983	5992	1 2 3	3 4 5	6 7 8
36	6000	6008	6017	6025	6033	6042	6050	6058	6066	6075	1 2 2	3 4 5	6 7 7
37	6083	6091	6099	6107	6116	6124	6132	6140	6148	6156	1 2 2	3 4 5	6 7 7
38	6164	6173	6181	6189	6197	6205	6213	6221	6229	6237	1 2 2	3 4 5	6 6 7
39	6245	6253	6261	6269	6277	6285	6293	6301	6309	6317	1 2 2	3 4 5	6 6 7
40	6325	6332	6340	6348	6356	6364	6372	6380	6387	6395	1 2 2	3 4 5	6 6 7
41	6403	6411	6419	6427	6434	6442	6450	6458	6465	6473	1 2 2	3 4 5	5 6 7
42	6481	6488	6496	6504	6512	6519	6527	6535	6542	6550	1 2 2	3 4 5	5 6 7
43	6557	6565	6573	6580	6588	6595	6603	6611	6618	6626	1 2 2	3 4 5	5 6 7
44	6633	6641	6648	6656	6663	6671	6678	6686	6693	6701	1 2 2	3 4 5	5 6 7
45	6708	6716	6723	6731	6738	6745	6753	6760	6768	6775	1 1 2	3 4 4	5 6 7
46	6782	6790	6797	6804	6812	6819	6826	6834	6841	6848	1 1 2	3 4 4	5 6 7
47	6856	6863	6870	6877	6885	6892	6899	6907	6914	6921	1 1 2	3 4 4	5 6 7
48	6928	6935	6943	6950	6957	6964	6971	6979	6986	6993	1 1 2	3 4 4	5 6 6
49	7000	7007	7014	7021	7029	7036	7043	7050	7057	7064	1 1 2	3 4 4	5 6 6
50	7071	7078	7085	7092	7099	7106	7113	7120	7127	7134	1 1 2	3 4 4	5 6 6
51	7141	7148	7155	7162	7169	7176	7183	7190	7197	7204	1 1 2	3 4 4	5 6 6
52	7211	7218	7225	7232	7239	7246	7253	7259	7266	7273	1 1 2	3 3 4	5 6 6
53	7280	7287	7294	7301	7308	7314	7321	7328	7335	7342	1 1 2	3 3 4	5 5 6
54	7348	7355	7362	7369	7376	7382	7389	7396	7403	7409	1 1 2	3 3 4	5 5 6

Find the first significant figure and the position of the decimal point by inspection.

## APPENDIX V

## SQUARE ROOTS

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
55	7416	7423	7430	7436	7443	7450	7457	7463	7470	7477	1 1 2	3 3 4	5 5 6
56	7483	7490	7497	7503	7510	7517	7523	7530	7537	7543	1 1 2	3 3 4	5 5 6
57	7550	7556	7563	7570	7576	7583	7589	7596	7603	7609	1 1 2	3 3 4	5 5 6
58	7616	7622	7629	7635	7642	7649	7655	7662	7668	7675	1 1 2	3 3 4	5 5 6
59	7681	7688	7694	7701	7707	7714	7720	7727	7733	7740	1 1 2	3 3 4	5 5 6
60	7746	7752	7759	7765	7772	7778	7785	7791	7797	7804	1 1 2	3 3 4	4 5 6
61	7810	7817	7823	7829	7836	7842	7849	7855	7861	7868	1 1 2	3 3 4	4 5 6
62	7874	7880	7887	7893	7899	7906	7912	7918	7925	7931	1 1 2	3 3 4	4 5 6
63	7937	7944	7950	7956	7962	7969	7975	7981	7987	7994	1 1 2	3 3 4	4 5 6
64	8000	8006	8012	8019	8025	8031	8037	8044	8050	8056	1 1 2	2 3 4	4 5 6
65	8062	8068	8075	8081	8087	8093	8099	8106	8112	8118	1 1 2	2 3 4	4 5 5
66	8124	8130	8136	8142	8149	8155	8161	8167	8173	8179	1 1 2	2 3 4	4 5 5
67	8185	8191	8198	8204	8210	8216	8222	8228	8234	8240	1 1 2	2 3 4	4 5 5
68	8246	8252	8258	8264	8270	8276	8283	8289	8295	8301	1 1 2	2 3 4	4 5 5
69	8307	8313	8319	8325	8331	8337	8343	8349	8355	8361	1 1 2	2 3 4	4 5 5
70	8367	8373	8379	8385	8390	8396	8402	8408	8414	8420	1 1 2	2 3 4	4 5 5
71	8426	8432	8439	8444	8450	8456	8462	8468	8473	8479	1 1 2	2 3 4	4 5 5
72	8485	8491	8497	8503	8509	8515	8521	8526	8532	8538	1 1 2	2 3 4	4 5 5
73	8544	8550	8556	8562	8567	8573	8579	8585	8591	8597	1 1 2	2 3 4	4 5 5
74	8602	8608	8614	8620	8626	8631	8637	8643	8649	8654	1 1 2	2 3 4	4 5 5
75	8660	8666	8672	8678	8683	8689	8695	8701	8706	8712	1 1 2	2 3 4	4 5 5
76	8718	8724	8729	8735	8741	8746	8752	8758	8764	8769	1 1 2	2 3 4	4 5 5
77	8775	8781	8786	8792	8797	8803	8809	8815	8820	8826	1 1 2	2 3 4	4 4 5
78	8832	8837	8843	8849	8854	8860	8866	8871	8877	8883	1 1 2	2 3 4	4 4 5
79	8888	8894	8899	8905	8911	8916	8922	8927	8933	8939	1 1 2	2 3 4	4 4 5
80	8944	8950	8955	8961	8967	8972	8978	8983	8989	8994	1 1 2	2 3 4	4 4 5
81	9000	9006	9011	9017	9022	9028	9033	9039	9044	9049	1 1 2	2 3 4	4 4 5
82	9055	9061	9066	9072	9077	9083	9088	9094	9099	9105	1 1 2	2 3 4	4 4 5
83	9110	9116	9121	9127	9132	9138	9143	9149	9154	9160	1 1 2	2 3 4	4 4 5
84	9165	9171	9176	9182	9187	9192	9198	9203	9209	9214	1 1 2	2 3 4	4 4 5
85	9220	9225	9230	9236	9241	9247	9252	9257	9263	9268	1 1 2	2 3 4	4 4 5
86	9274	9279	9284	9290	9295	9301	9306	9311	9317	9322	1 1 2	2 3 4	4 4 5
87	9327	9333	9338	9343	9349	9354	9359	9365	9370	9375	1 1 2	2 3 4	4 4 5
88	9381	9386	9391	9397	9402	9407	9413	9418	9423	9429	1 1 2	2 3 4	4 4 5
89	9434	9439	9445	9450	9455	9460	9466	9471	9476	9482	1 1 2	2 3 4	4 4 5
90	9487	9492	9497	9503	9508	9513	9518	9524	9529	9534	1 1 2	2 3 4	4 4 5
91	9539	9545	9550	9555	9560	9566	9571	9576	9581	9586	1 1 2	2 3 4	4 4 5
92	9592	9597	9602	9607	9612	9618	9623	9628	9633	9638	1 1 2	2 3 4	4 4 5
93	9644	9649	9654	9659	9664	9670	9675	9680	9685	9690	1 1 2	2 3 4	4 4 5
94	9695	9701	9706	9711	9716	9721	9726	9731	9737	9742	1 1 2	2 3 4	4 4 5
95	9747	9752	9757	9762	9767	9772	9778	9783	9788	9793	1 1 2	2 3 4	4 4 5
96	9798	9803	9808	9813	9818	9823	9829	9834	9839	9844	1 1 2	2 3 4	4 4 5
97	9849	9854	9859	9864	9869	9874	9879	9884	9889	9894	1 1 2	2 3 4	4 4 5
98	9899	9905	9910	9915	9920	9925	9930	9935	9940	9945	0 1 1	2 2 3	3 4 4
99	9950	9955	9960	9965	9970	9975	9980	9985	9990	9995	0 1 1	2 2 3	3 4 4

Find the first significant figure and the position of the decimal point by inspection.



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